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# SOLITARY MYELOMA OF BONE[1]

## A REVIEW OF THE ROENTGENOLOGIC FEATURES, WITH A REPORT OF FOUR ADDITIONAL CASES

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THE purpose of this communication is to review a series of cases of solitary myeloma of bone as recorded in the literature, with particular reference to the roentgenologic features, and to report four additional new cases.

Solitary myelomatous tumors of bone are generally conceded to be of rare occurrence and the majority of those published have been in the form of single case reports. Geschickter and Copeland (18) found only five recorded in the literature in 1931. Cutler, Buschke, and Cantril (12), in 1936, reviewed 12 cases from the literature together with five others from the Registry of Bone Sarcoma of the American College of Surgeons not previously reported, and added another, a total of 18. Since their article, other cases have been described and we wish to add four more, also not previously recorded.

In this connection it should be mentioned that there is a distinct group of plasma-cell tumors which seems to have a predilection for the mucous membrane of the nose and nasopharynx. These tumors have received special attention in the rhinologic and pathologic literature. Blumenfeld (4) brought the subject up to date (1935) on this particular phase of myeloma. A total of 21 cases were reviewed by him including one of his own. Histologically these tumors are identical with plasma-cell myeloma of bone but show less tendency to metastasize. The etiologic factors have not been definitely established. Most writers on the subject believe them to be true neoplasms related to malignant lymphoma and to be only a variant of multiple myeloma of the plasma-cell type.

In reviewing these cases it is difficult to segregate them from myeloma originating in bone. Destruction of the bony structures adjacent to the tumor is sometimes present, and the possibility that the lesion originated in bone must be given consideration. The case of Cappell and Mathers (8) illustrates the difficulties encountered. The tumor in this patient involved the petrous pyramid and base of the skull: at postmortem examination it was the only focus found. The patient had had a chronic otorrhea for many years, and the authors were not certain whether the lesion should be classed as a myeloma of bone or as one originating from the mucous membrane of the mastoid cells. A case reported by Gross and Vaughan (19) also illustrates the

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same difficulty. The original lesion which occurred in the maxillary antrum and was treated surgically, recurred and a swelling developed in the region of the middle of the right tibia. Some time later this became enlarged and painful and roentgen examination showed an expansile, multilocular, cystic lesion involving the tibial shaft, very similar in appearance to others recorded in the literature. The authors cite this case as a plasma-cell myeloma and do not mention the possibility that the lesion in the antrum may have originated in the mucous membrane. Nevertheless those tumors occurring in the nose and nasopharynx have a somewhat different clinical picture and since extra-osseous myelomas do occur, this group should be segregated as much as possible from those definitely primary in bone, even though they seem to be very similar pathologically. For a discussion of the subject of this form of myeloma the articles by Blumenfeld (4), Claiborn and Ferris (11), and Blacklock and Macartney (2) are cited.

The nature of myeloma still is an unsolved problem. A résumé of current opinion on the subject was given in a recent editorial in the *Journal of the American Medical Association* (14) in which it was stated that classification of myeloma on a histologic basis does not seem justified, since the essential histologic picture of this tumor is that it is made up of all the immature elements of the bone marrow. In that respect it seems to be related to the leukemias and aleukemias. There is also some evidence to show that "multiple myeloma" is multiple insofar as the cases are observed only after diffuse spread has occurred. Some of the follow-up observations made on cases of solitary myeloma certainly support this view. Nevertheless, there are certain features in most of the cases of solitary myeloma recorded in the literature which tend to place this group apart from the usual, so-called multiple form. This will be considered in further detail later on in this paper. Cutler *et al.* (12) believe it is possible to separate further the solitary forms of myeloma into two distinct groups, the first solitary only in the beginning and subsequently becomes generalized; the second and rare type remains solitary throughout its course, and prolonged observation (four to ten years) proves that it remains local.

Since roentgen examination is relied upon in large measure to establish the presence and possible nature of lesions of bone, it seemed desirable to review the cases available in the literature, in order to determine, if possible, the roentgenologic aspects of solitary myeloma. As with other rare lesions, the individual roentgenologist seldom has an opportunity to see more than a few cases of this type and only by correlating the experiences of others is there any hope of establishing a definite diagnostic entity.

## REVIEW OF CASES

Including our five cases (four new ones and one previously reported), we have reviewed a series of 45 single focus type of myeloma of bone.

*Clinical Aspects.*—While this study was conducted primarily from the roentgenologic point of view, certain features in the clinical picture are worthy of note. In Table I are listed the salient facts of the cases reviewed. Table II shows the age and sex distribution. There were 35 males and 10 females. Except for one infant 19 months old, the age varied from 29 to 71 with an average of 48. More cases (16) occurred in the fifth decade than in any other, the remainder being distributed rather equally between the third, fourth, and sixth. Of considerable interest is the location of the lesions (Table III). The dorsal spine (9 cases), pelvis (10 cases), and femur (8 cases) were the most frequent sites of involvement. In three instances the lesion was found in the skull, five times in the humerus, three times in the cervical spine, twice in the lumbar spine and jaws, and single cases occurred in the clavicle, tibia, and sternum. In the pelvis, the ilium was the most frequent site and in the femur all eight cases were found in the proximal part. The duration of symptoms before

the first observation varied from a few weeks to four years. The total period of observation likewise varied considerably from a few days to 12 years. In those patients in whom the disease became generalized, the time from the first observation to the onset of generalization varied from two months to three years. The longest recorded observation was reported by Vihvelin (40). This patient was alive although showing evidence of tumor recurrence, 12 years after being first seen.

TABLE I

| CASE NO. SOURCE | AGE SEX | LOCATION | X-RAY DESCRIPTION | CELL TYPE | B.J. PROT. | TREATMENT | RESULT | Duration of symptoms to 1st observ. | Time from 1st observ. to spread | Total period of observation | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Zdansky | 64 F | Femur, upper 1/3 | Irreg. area rarefaction 8 cm. long. Cortex thin and in some areas destroyed. Pathological fracture. | Plasma cell | | | Dead | 1 year | | few days | Autopsy. Single focus. |
| 2. MacFee (Geschickter) | 45 M | Femur, upper 1/3 | Circumscribed osteolytic lesion extending longitudinally. Cortex intact. No periostitis or expansion. | Plasma cell | + late | Curettage Cautery Toxins, X-ray. | Living | 2 mo. | 3 yrs. | 6½ yrs. | Patient living but has second lesion in $L_2$. Able to be around. Progressive anemia. |
| 3. Mallgren | 41 F | Maxilla | Defect in alveolar process. | Plasma cell | + early | Resection | Dead | few weeks | | ? | Died post-op. Autopsy. Single focus. |
| 4. Rogers | 34 M | Femur | Fracture. Honeycombing of bone, rarefaction, expansion. | Plasma cell | 0 | Curettage Radium Amputation | Living | 7 mo. | | 4 yrs. | Living, good health, no sign of recurrence. |
| 5. Shaw | 29 M | Humerus, middle | Fracture. Absorption and reticulation of bone suggesting central medullary tumor. | Plasma cell | 0 | Curettage Bone graft | Living | 1 wk. | | 1 yr. | Living, no sign of recurrence or spread. |
| 6. Charbonnier, Mermod | 62 F | Femur, upper 1/3 | Fracture. Bone rarefied and cortex irregular, thin and cystic. | Plasma cell | 0 | Curettage | Dead | 2 to 3 months | | 6 mo. | Died 6 mo. after first seen. Autopsy - single focus. |
| 7. Walthard | 55 M | Vertebra, $C_7$ & $D_1$ | | Plasma cell | | Laminectomy curettage | Dead | 10 mo. | | Died post-op. | Autopsy - single focus. |
| 8. Mathias | 65 M | Skull, parietal | | Plasma cell | 0 | Excision | Living | ? | | 18 mo. | Living at time of report. No recurrence or spread. |
| 9. Cabot Case No. 16482 | 32 M | Vertebra, $D_4$ | Liplodol block at dorsal 4. X-rays of spine otherwise negative. | Myeloma | | Laminectomy | Dead | 6 wks. | | 15 days | Autopsy - single lesion. |
| 10. Harding, Tindall | 60 M | Femur, upper 1/3 | Fracture at level of trochanters. Osteolytic lesion confined to this area. | Plasma cell | 0 | Disarticulation. | Dead | 18 mo. | | 2 mo. | Died 2 mo. after operation. Autopsy - single lesion. |
| 11. Cutler, Bone Reg. No. 1240 | 39 F | Ilium | Large tumor having appearance of giant cell. | Plasma cell | + early | Biopsy, X-ray | Dead | 2 yrs. | | 23 mo. | Autopsy - single lesion. |
| 12. Cutler, Bone Reg. No. 1195 | 58 M | Ilium | Large area of decreased density with trabeculation. | Plasma cell | | Biopsy, X-ray | Living | ? | | 20 mo. | Living. General condition excellent. |
| 13. Cutler, Bone Reg. No. 1167 | 52 M | Vertebra, $L_2$ | Destructive lesion, diagnosed as giant cell tumor. | Plasma cell | 0 | X-ray Stabilization operation | Living | ? | | 10 yrs. | Living after 10 yrs. Disease has extended to adjoint vertebrae. |
| 14. Bloodgood | Adult | Clavicle outer 1/3 | Uniform expansion with only thin shell of bone left. Bone cyst or giant cell tumor? | Myeloma | + | Resection | Living | 13 mo. | 2 mo. | 2 mo. | Living 2 mo. after first seen but one new focus in a rib. |
| 15. Peyton | 49 M | Vertebra, $D_6$ | $D_6$ compressed and rarefied. Disc between $D_5$ and $D_6$ almost obliterated with paravert. dert tissue shadow. | Plasm cell | + late | Laminectomy, Radium, X-ray | Dead | 14 mo. | 2 to 3½ yrs. | 3 yrs. 9 mo. | Generalized metastases some time between 19 mo. and 3½ yrs. |

(Continued on next page)

Twenty-eight patients were still living at the time of the report and 24 of these were free from evidence of spread. Bence-Jones protein was found in the urine of nine patients (20 per cent), a low incidence compared to the multiple form, and when it was found it was usually only after generalization had occurred.

TABLE I. (*Cont.*)

| CASE NO. SOURCE | AGE SEX | LOCATION | X-RAY DESCRIPTION | CELL TYPE | B.J. PROT. | TREATMENT | RESULT | Duration of symptoms to 1st observ. | Time from 1st observ. to spread | Total period of observation | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16. Cutler (Peyton) | 38 F | Skull, parietal | Large defect in the bone. | Plasma cell | + early | X-ray | Dead | 4 mo. | 2 mo. | 3 yrs., 4 mo. | Generalized metastases, first in skull, later to rest of skeleton. Autopsy. |
| 17. Cutler, Bone Reg. No. 710 | 56 M | Femur, upper 1/3 | Intramedullary tumor at and below trochanters suggesting giant cell tumor. Cortex thinned. | Plasma cell | + late | Curettage | Dead | 1 mo. | 2 yrs. 9 mo. | 3 yrs. | Autopsy, multiple myeloma. |
| 18. Cutler, Bone Reg. No. 1597 | 57 M | Humerus, prox. 1/2 | Destruction below head with extension into soft tissues. Fracture. Diagnosed sarcoma. | Plasma cell | + late | Resection, X-ray | Dead | 7 mo. | 9 mo. | 2 yrs., 4 mo. | Became typical multiple myeloma. Lived 1½ yrs. after first spread. |
| 19. Cappell, Mathers | 57 F | Skull, mastoid | | Plasma cell | | Operation, interstitial radium | Dead | 4 yrs. | | 5 mo. | Autopsy, single lesion. |
| 20. Liebman, Goldman | 50 M | Ilium | Large cystic and trabeculated area lower half ilium breaking through cortex. Multilocular. | Myeloma | 0 | Biopsy, X-ray | Living | 6 mo. | | 16 mo. | Condition improved, no spread. |
| 21. Chesterman | 39 M | Tibia, upper 1/3 | Well defined, cystic lesion expanding cortex. Fracture. | Plasma cell | 0 | Amputation | Living | 3½ mo. | | 5 mo. | In good health at time of report, 5 mo. after first seen. |
| 22. Wright | 31 M | Vertebra, $D_8$ | Destruction of vertebral body. Neoplasm or tbc.? | Plasma cell | 0 | Curettage, radon seeds | Living | 6 wks. | | 1 yr. | Condition practically normal when last seen. |
| 23. Cabot Case, No. 24192 | 71 M | Vertebra, $D_8$ | Erosion, rt. pedicle. Right side of body deformed and rarefied. Soft tissue shadow. Lipiodol block. | Plasma cell | | Curettage, X-ray | Living | 3 mo. | | 35 days | No improvement at time of report, 35 days after first seen. |
| 24. Bailey | 65 M | Humerus, shaft | Extensive honeycombing of nearly all of shaft with fracture. | Plasma cell | | Biopsy, X-ray | Living | 1 yr. | | 7 yrs. | Patient is well. Lesion has recalcified. |
| 25. Leedham-Green | 41 M | Ilium | Multilocular, destructive cystic lesion involving most of one ilium. Giant cell? | Plasma cell | 0 | Biopsy, X-ray | Living | 12 mo. | | 6 mo. | Condition good. Some recalcification after x-ray therapy. |
| 26. Leedham-Green | 56 M | Innominate | Destruction of lt. innominate. | Plasma cell | 0 | Biopsy, X-ray | Living | 4 yrs. | | 2 yrs., 5 mo. | Tumor showed recalcification after x-ray. No spread. |
| 27. Denker, Brock | 48 M | Vertebra, $D_4$ | Destruction of body with some lateral buckling. | Plasma cell | 0 | Curettage, X-ray | Living | 9 mo. | | 10 mo. | General condition good. No evidence of spread after 10 mo. |
| 28. Jarre | 50 M | Vertebra, $D_7$ | Areas of destruction in body and pedicles. Lipiodol block. | Plasma cell | 0 | Partial removal, X-ray | Dead | 5 mo. | | 10½ mo. | Death apparently due to heart failure. No autopsy. Bones neg. to x-ray 2 mo. before death. |
| 29. Rosselet, Decker | 55 M | Vertebra, $C_5$ to $C_7$ | Destruction of bodies and transverse processes. Discs destroyed. | Plasma cell | | Partial removal, X-ray | Living | 2 mo. | | 4 yrs. | Living after 4 yrs. Recent local recurrence responded to x-ray. |
| 30. Satanowsky, Gonzalez | 36 F | Pelvis | Destruction of acetabulum and adjacent innominate. Intrapelvic protrusion of head of femur. | Plasma cell | | | Dead | 3 mo. | | 7 wks.? | Died from cerebral hemorrhage, no other tumors at autopsy. |

TABLE I. (*Cont.*)

| CASE NO. SOURCE | AGE SEX | LOCATION | X-RAY DESCRIPTION | CELL TYPE | B.J. PROT. | TREATMENT | RESULT | DURATION of symptoms to last observ. | TIME from last observ. to spread | DURATION of period of observation | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31. Fontz Abreu | 50 M | Sacrum | Destruction rt. wing of sacrum with cystic, trabeculated appearance. | Plasma cell | 0 | | Living | 3 yrs. | | 20 mo. | Lesion partly recalcified. Patient in good health. |
| 32. Vihvelin | 59 M | Vertebra, $D_7$ | Lipiodol block, $D_7$. 7 yrs. later destruction $D_{7,8}$ — 5 yrs. later, destruction $D_7$ to $D_{11}$. | Plasma cell | | Curettage repeated | Living | 14 mo. | | 12 yrs. | Several recurrences during 12 yr. period. No generalization. Still evidence of local disease. |
| 33. Jacox, Kahn | 31 M | Vertebra, $L_3$ | Body partially reduced in size due to destruction with involvement of lamina. Later, extension to $L_2$ & $L_4$. | Plasma cell | + late | Curettage, X-ray | Living | 2 yrs. | 4 yrs., 5 mo. | 5 yrs., 5 mo. | Typical mult. myeloma for past year but symptom free after irradiation. |
| 34. Stewart, Taylor | 34 M | Humerus, proximal | Endosteal tumor upper end humerus with much expansion and thinning of bone and trabeculation. Fracture. | Plasma cell | | Amputation | Living | 5 mo. | | 8 yrs. | In perfect health after 8 yrs. No evidence of spread. |
| 35. Stewart, Taylor | 43 M | Maxilla | None. | Plasma cell | | Curettage | Living | 6 mo. | | 8 yrs. | In good health. Had small swelling in frontal area, disappeared after x-ray. Nothing since. |
| 36. Pasternack, Waugh | 46 M | Humerus, proximal | Destruction, trabeculation and cortical expansion upper end humerus with path. fracture. Giant cell? | Plasma cell | 0 | X-ray, Resection | Living | 2 mo. | | 8 yrs. | Living after 8 yrs. No recurrence or spread. |
| 37. Martin et al | 56 F | Femur, neck | Appearance of giant cell tumor or cyst. | Plasma cell | | Disarticulation | Living | 4 mo. | | 2 yrs. | Living after 2 yrs. No recurrence or spread. |
| 38. Mercier | 51 M | Ilium | Appearance of giant cell tumor. | Plasma cell | 0 | Excision | Dead | 11 mo. | | 3 yrs. | Died after 3 yrs. Local recurrence. |
| 39. Mercier | 49 F | Ilium | Appearance of giant cell tumor. | Plasma cell | 0 | Biopsy | Dead | 3 yrs. | | few months | Died shortly after first seen. |
| 40. Mancini | 19mo. F | Femur, upper 1/3 | Appearance of giant cell tumor. | Myeloma | | Exploration, X-ray | Living | 6 wks. | 7 mo. | 20 mo. | Second focus in skull after 7 mo. Disappeared after x-ray. |
| 41. Pohle, Stovall | 49 F | Ilium | Expansile, osteolytic lesion with fine trabeculations, anterior ilium. Later, multiple myeloma. | Plasma cell | ? once | Biopsy, X-ray | Dead | 8 mo. | 6 mo. | 4 yrs., 4 mo. | First lesion recalcified after x-ray. Generalization 6 mo. later. No autopsy. |
| 42. Paul, Pohle | 60 M | Vertebra, $C_3$ | Nearly complete destruction of $C_3$ including spinous process. Later extension to $C_2$ and $C_4$. | Plasma cell | 0 | Partial removal, X-ray | Living | 7 mo. | | 19 mo. | Symptoms improved but has extended to adjacent vertebra. Other bones neg. to x-ray. |
| 43. Paul, Pohle | 59 M | Sternum, upper end | Irreg. destruction manubrium with expansion and trabeculation. Cortex fragmented. | Plasma cell | 0 | Biopsy, X-ray | Living | 6 wks. | | 4 mo. | Improved. No evidence of spread. |
| 44. Paul, Pohle | 54 F | Vertebra, $D_1$ & $D_2$ | Extensive destruction of bodies and of disc between. Lamina on rt. side involved. | Plasma cell | 0 | Partial removal, X-ray | Living | 3 mo. | | 8 mo. | Condition greatly improved. Lesion arrested and no evidence of spread to x-ray exam. |
| 45. Paul, Pohle | 39 M | Vertebra, $D_{10}$ | Marked destruction and compression $D_{10}$. Soft tissue mass on left. Later, typical multiple myeloma. | Plasma cell | 0 | Biopsy, X-ray | Dead | 8 mo. | 8 mo. | 1 yr. | Developed typical multiple myeloma before death. Autopsy. |

*When operation consisted only of biopsy it is so indicated. All other operative cases had biopsy in addition.

*Roentgen Appearances.*—Roentgenologically speaking, two main types of lesion occur. The first is characterized by an osteolytic, multicystic-appearing area of rarefaction somewhat simulating giant-cell tumor. The lesion usually is sharply demarcated, centrally located in the medulla when occurring in a long bone, and may or may not expand the bone. The area of destruction is crossed by irregular and some-

times rather thick trabeculæ. In some of the cases destruction of cortex in areas was found but more commonly the cortex was intact. No periosteal reaction was produced. Pathologic fracture through the tumor was a frequent occurrence and in some instances it was this mishap which led to the discovery of the causative lesion. This multicystic type of tumor was encountered especially in the pelvic lesions and in some of the cases involving the long bones. It was often mistaken, roentgenologically, for giant-cell tumor.

The second type of lesion seen was a purely destructive one. This too was commonly located intramedullary and, in the long bones, tended to extend up and down the shaft. The margins were sharply demarcated and expansion was present occasionally. The essential differences between this lesion and the cystic form, when occurring in a long bone, were the absence of trabeculations and less tendency for expansion. This osteolytic type was the one commonly encountered in the spine and the roentgenographic appearance of these spinal lesions deserves particular mention. The lesion, in most instances, was limited to a single vertebra but in some the tumor involved one or more contiguous vertebræ. Also, in some of the cases in which one vertebral body was involved primarily, follow-up studies showed later extension to adjacent bodies. This tendency for the lesion to extend across the intervertebral discs and involve adjacent bones by direct extension is worthy of note. Bone destruction was the prominent feature and resulting loss in height of the involved body was noted, while in some instances the involved

TABLE II.—AGE AND SEX DISTRIBUTION

| Age in decades | Number of cases | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 0–10 | 19 mo. F | | | | | | | | | | | | | | | |
| 10–20 | | | | | | | | | | | | | | | | |
| 20–30 | 29 M | | | | | | | | | | | | | | | |
| 30–40 | 34 M | 32 M | 39 F | 38 F | 39 M | 31 M | 36 M | 31 M | 34 M | 39 M | | | | | | |
| 40–50 | 45 M | 41 F | 49 M | 41 M | 48 M | 43 M | 46 M | 49 F | 49 F | | | | | | | |
| 50–60 | 55 M | 58 M | 52 M | 56 M | 57 M | 57 F | 50 M | 56 M | 50 M | 55 M | 50 M | 59 M | 56 M | 51 M | 59 M | 54 F |
| 60–70 | 64 F | 62 F | 65 M | 60 M | 65 M | 60 M | | | | | | | | | | |
| 70–80 | 71 M | | | | | | | | | | | | | | | |

(One case, listed only as an adult male, not included.)

Total no. males - 35.
Total no. females - 10.

body disappeared completely. No proliferative bony changes were described. In the dorsal spine a paravertebral soft-tissue shadow was mentioned in several instances; involvement of the vertebral processes occurred in some. Uniform flattening of the vertebral body could then result, due to lack of support posteriorly. Lateral or interior wedging was more frequent.

*Pathologic Types.*—The plasma-cell type of myeloma predominated, there being 41 cases of this form. In four cases the microscopic diagnosis was given only as "myeloma," or else it was stated that the lesion was of the mixed type. As has been indicated, differentiation between the various types of cells present many be impossible and probably is unnecessary.

*Treatment.*—An analysis of the type of treatment used in the cases reviewed here shows that surgical or radiologic procedures alone or combined have been tried. Surgery varied from biopsy and curettage to partial removal of the growth, complete resection, amputation of an extremity and disarticulation. Irradiation has been administered in the form of external x-ray or radium therapy and interstitial radium. As an adjunct, toxins were given in one instance. The two largest groups were treated by biopsy plus roentgen therapy or by more or less radical surgical removal alone. Since the total number of cases is relatively small, it is difficult to evaluate statistically the various therapeutic methods, but certain impressions can be gained by a study of Table I. One can hardly deny that biopsy followed by x-ray therapy seems to offer the best chance to the patient with solitary myeloma since the average prolongation of life in that group is considerably longer than for any other combination of treatment. In individual patients one sees occasionally a remarkable response to therapy, with freedom from symptoms for over seven years or more (Case 24), although most of them develop sooner or later either a recurrence or the generalized type of myeloma; however, even in that case, the lesions may still respond to irradiation (Case 35).

## DISCUSSION

(1) *Authenticity of Cases.*—All of the cases included in this report had microscopic diagnosis of tissue removed at biopsy or postmortem examination. The difficulty of separating the cases of myeloma arising from the mucous membranes of the nose and nasopharynx from those arising in bone has been mentioned previously. As far as can be determined none of the cases included here belong to the former group. As a matter of fact, when generalization of the mucous membrane type takes place it may assume the form of typical multiple myeloma and, pathologically, the two are identical. Claiborn and Ferris (11) believe that most of these mucous membrane myelomas are benign and that most of those that appear to be malignant are probably manifestations of multiple myeloma.

TABLE III.—ANATOMICAL DISTRIBUTION OF LESIONS

| PART | NUMBER OF CASES |
|---|---|
| Skull | 3 |
| Jaws | 2 |
| Clavicle | 1 |
| Sternum | 1 |
| C. Spine | 3 |
| D. Spine | 9 |
| L. Spine | 2 |
| Pelvis | 10 |
| Humerus | 5 |
| Femur | 8 |
| Tibia | 1 |
| Total | 45 |

In several cases the records are not clear as to the extent of search for other foci, but the symptomatology, clinical findings, and course of the disease point to the lesion being of the single focus type at the time of first observation. Incidentally, it is recognized that neither complete roentgen-ray studies of the skeleton nor autopsy examination will disclose every possible focus of disease, but of the two it is believed that roentgen study is the more reliable for discovering scattered foci, since, in the average necropsy, complete investigation of all of the bones is not made. Some of the cases reported have not been included because of lack of data. It is likely that others may have been included in papers dealing with a more general subject matter and there probably are many that have never been published.

(2) *Relation of Single to Multiple Forms.*—The opinion that the multiple form of myeloma is multiple at the time of first observation only because spread occurred early from a primary focus is an interesting speculation, and this study tends to support that view. When generalization occurs it may assume the typical appearance of multiple myeloma. This was true in one of our cases (Case 2). In some instances only a few new foci appear and patients have lived after various forms of therapy for periods up to eight, ten, and, in one instance, twelve years. However, the statement that solitary myeloma of bone is always relatively benign is not true. The interval from the first observation to the time of report was not long enough in many cases to evaluate the degree of malignancy of the lesion. That relatively benign forms of myeloma do occur must be admitted and the giant-cell type seems to be less likely to metastasize than the osteolytic form. It seems reasonable to assume that myeloma may occur in varying degrees of malignancy with early spread in some (typical multiple myeloma) and, at the other end of the scale, a benign form which remains local, providing reasonably efficient methods of treatment are employed for its eradication. Between these two extremes, many grades of malignancy may be found (2, 37). This opinion is held by others and, as stated by Stewart and Taylor (37), there is, obviously, no dividing line between the simple and malignant forms, and it appears that solitary plasma-cell tumors belong rather to an intermediate (locally malignant) group than definitely to either end of the scale. The wide variation in the duration of the disease, as indicated in this report, from the time of onset of symptoms to the first observation, the time elapsed before generalization occurred, and the length of life in some patients, even with relatively little treatment, favor such a view. Another point in favor of such a supposition is the known fact that even in cases showing the typical multiple punched-out defects in the spine, pelvis, ribs, and skull, occasionally one or more of the lesions will show a cystic trabeculated appearance similar to that noted in the single focus type of the disease (38).

(3) *Roentgen Diagnosis and Differential Diagnosis.*—The characteristic features of single myeloma of bone as recorded in this series of cases have already been mentioned. The confusion with giant-cell tumor was a common one. In this respect, the location of the lesion is important. Simple giant-cell tumor is, predominantly, a lesion of the epiphyseal ends of bone. Its occurrence in other locations is rare. Cases have been reported of its appearance in the ribs, spine, and other flat bones, but pathologic proof was not always available. Given a cystic trabeculated lesion, expansile in character with evidence of some cortical destruction, and located in an atypical place for giant-cell tumor, myeloma should be given consideration. The favorite sites being in the dorsal spine, pelvis, and proximal femur, lesions of this character in these areas should arouse the suspicion of myeloma.

Solitary myeloma of the multicystic type also may be confused with localized fibrocystic disease of bone. These latter lesions, characteristically, are found in the diaphysis of a long bone, the proximal humerus and femur being favorite sites.

They occur at an earlier age period than myeloma, usually before the age of twenty. As a rule they are asymptomatic until fracture occurs, while most myelomas give a history of pain and dysfunction prior to fracture.

Pre-operative diagnoses of osteogenic sarcoma and Ewing's tumor were made in several cases. Absence of periosteal reaction, the presence of expansion and trabeculation, and the purely osteolytic character of the lesion would be against the diagnosis of Ewing's tumor. Myeloma usually lacks the invasive qualities of osteolytic osteogenic sarcoma. The margins of the bone defect are smoother and more sharply defined, but when the tumor has been of rapid growth, differentiation may be impossible.

In the spine, myeloma may be confused with tuberculosis, particularly so if a paravertebral soft-tissue shadow is present. Here, one must rely on the character of the changes in the bone, which, at least, should be sufficient to differentiate between an inflammatory and a neoplastic process.

The differentiation between the osteolytic form of single myeloma and the destructive type of metastasis is even more difficult. Both produce destruction of bone, the age period is similar, and the favorite sites of involvement are much the same. While metastatic malignancy commonly assumes a multiple form in the bones, it does occur, early, as a single lesion often enough so that this feature is of no great help. In the spine, visualization of a paraspinal soft-tissue mass probably is more common in myeloma. Absence of sclerosis is the rule in myeloma, while many metastatic lesions show some evidence of sclerosing reaction. In the majority of metastatic tumors a primary growth can be demonstrated by thorough study but, again, exceptions occur in sufficient number to make this of doubtful value. Pathologic fracture is common to both. The ability of myeloma to cross cartilage and involve contiguous bones is of importance and, in our experience, this is rare in carcinoma. Expansion of the cortex is a frequent finding in solitary myeloma, but unusual in carcinoma.

Other rare tumors may simulate myeloma. Teufel (39) reports a case of cylindroma of the ilium, and the roentgen appearance as illustrated in his paper seems hardly different from that seen in myeloma. Certain types of hemangioma of bone, according to Bucy and Capp (5), may show a soap-bubble type of multicystic involvement and from some of the illustrations in their article the appearance is very similar to myeloma.

(4) *Treatment.*—As pointed out before, the treatment of solitary myeloma has been either surgical or radiologic or a combination of both. We believe that no type of therapy should be instituted before a biopsy has established the correct diagnosis beyond doubt. In some instances it is possible to remove the lesion entirely by operation; in others, anatomic location permits only of partial removal or curettement. All cases should have the benefit of post-operative radiation therapy.

A scrutiny of the literature and our own experience seems to support the contention that roentgen rays are perhaps the most efficient single therapeutic agent in dealing with solitary myeloma, although it is quite true that, even with them, permanent cures are not often obtained. However, the palliative effect and the prolongation of life are definitely worth while. If a solitary lesion in an extremity recurs after irradiation, amputation should be seriously considered.

As to the technic, it has been our practice to use conventional x-ray deep therapy in doses of 200 r (in air) per day up to a total dose of from 1,200 to 1,600 r per field. In cases with generalized involvement so-called "general body exposure" has been administered with good response in some instances.[2] The results observed in our own group are recorded in Table I. We have had no experience with radium therapy in this condition but it seems evident

[2] The technic is described in detail in "Clinical Roentgen Therapy," edited by E. A. Pohle, M.D., page 42. Lea & Febiger, Philadelphia, 1938.

Fig. 1-*A*.

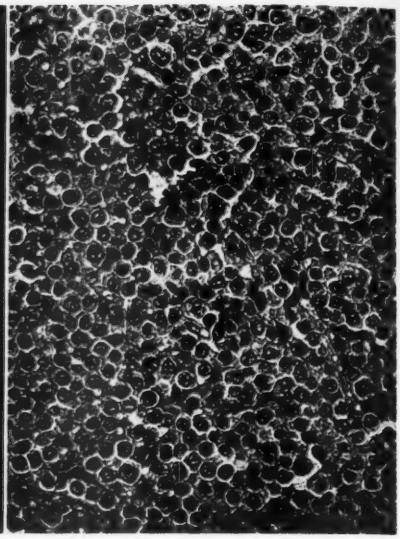

Fig. 2.

Fig. 1-*A*.- Case 1. Appearance of lesion in right ilium at the time of first admission, May 17, 1935.
Fig. 2. The sections show a compactly cellular tumor without stroma. The cells are small and uniform in size and staining reaction. The nucleus is placed excentric, and contains blocks of chromatin arranged along the nuclear membrane. Mitosis is not seen. The cytoplasm is stained pink. Diagnosis as follows: myeloma, plasma cell in type. (Zeiss apochr. 20, Homal I; × 500.)

Fig. 1-*B*. Case 1. Appearance of lesion in February, 1937.

that for efficient treatment large amounts of radium in the form of the so-called bomb (telecurietherapy) are required, unless interstitial irradiation is used.

## CASE REPORTS

Case 1 (M. J.). This patient was the subject of a report by Pohle and Stovall (32), and only a brief résumé, including a recent follow-up, will be given. The patient was a white female, aged 49, first admitted to the State of Wisconsin General Hospital on May 13, 1935. She gave a history of having slipped and fallen on the right hip eight months previously. She walked with a limp after this accident and walking became progressively more painful until eventually she was unable to bear weight on the leg. Roentgen examination demonstrated an expansile osteolytic lesion involving most of the right ilium (Fig. 1). The cortex was very thin, but intact, and some faint trabeculations were visible throughout the tumor mass. A provisional diagnosis of giant-cell tumor was made. Biopsy was done on May 20, 1935, and histologic diagnosis of tissue removed was plasma-cell myeloma (Fig. 2). Roentgen therapy was started on May 22, and 1,000 r was given to an anterior and a posterior field in daily fractions of 200 r to each field.[3] On July 30, 1935, an additional 1,400 r was given to each port in daily fractions of 200 r. On Nov. 11, 1935, examination revealed distinct recalcification of the lesion. An additional 600 r was given to

[3] All doses refer to r "in air."

Fig. 3.

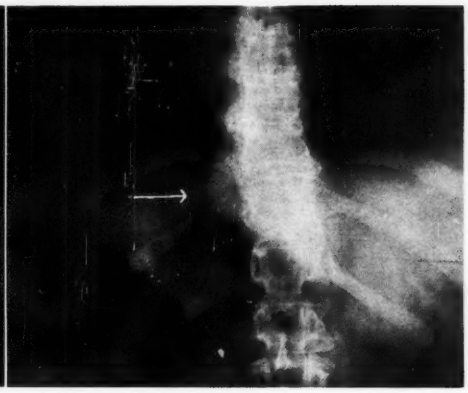

Fig. 4.

Fig. 3. Case 2. Lateral view of the dorsal spine. The body of D10 is compressed into a narrow wedge producing a considerable gibbus. The disc spaces are fairly normal.
Fig. 4. Case 2. Anteroposterior view. Note soft-tissue mass on the left side at the level of D10.

each field, fractionated as before, and on April 22, 1936, another series of treatments totalling 800 r was begun. The patient was again admitted to the hospital on Nov. 26, 1936, complaining of pain in the lower back. Roentgen examination showed a diffuse rarefaction of the lumbar vertebræ, with some collapse of the bodies evident. She was given six daily treatments of 200 r each to the lumbar spine through one posterior field. Re-examination on Feb. 11, 1937, showed a progression of the lesions in the lumbar spine. General body radiation was given, 25 r being administered to each of four fields to include the entire body surface. She was not seen again by us but her referring physician informed us that she died on Sept. 5, 1939. She had been confined to bed at home since her last admission to the hospital in February, 1937. She had suffered pathologic fractures of the right thigh and left arm from trivial causes a few months before death. For about a year before death several soft masses had been noted over the skull and these had slowly increased in size. While no roentgen examination was possible, there had evidently been a wide dissemination of the myeloma throughout the skeleton. The total duration of the disease from the time of onset of symptoms to death was five years.

Case 2 (R. T.). The patient, a white male, aged 39, was first admitted to the hospital on April 9, 1936. His chief complaint was difficulty in walking. About eight months prior to admission he had developed a "sore spot" in the middle of the back after throwing a baseball. Four months later he noticed numbness of the toes which gradually became worse. He continued working until two weeks prior to admission, when he had had to stop because of the continued pain in the back and the increasing difficulty in walking. On physical examination a sharp posterior angulation of the spine at the level of the tenth dorsal vertebra was found. Neurologic examination revealed a shuffling gait. He was unable to lift the right foot off the floor and could not stand on one foot or with the feet together. Reflexes were hyperactive, with an abortive ankle clonus and a positive Babinski on both sides. Tactile discrimination and pain and temperature sense were lost below the waist. Roentgen examination of the spine showed a well marked kyphosis with gibbus formation at the level of the tenth dorsal vertebra. This body was almost completely destroyed, with only a narrow, flattened portion remaining and the highest point, the posterior, measured not more than a centimeter. The discs between this body and

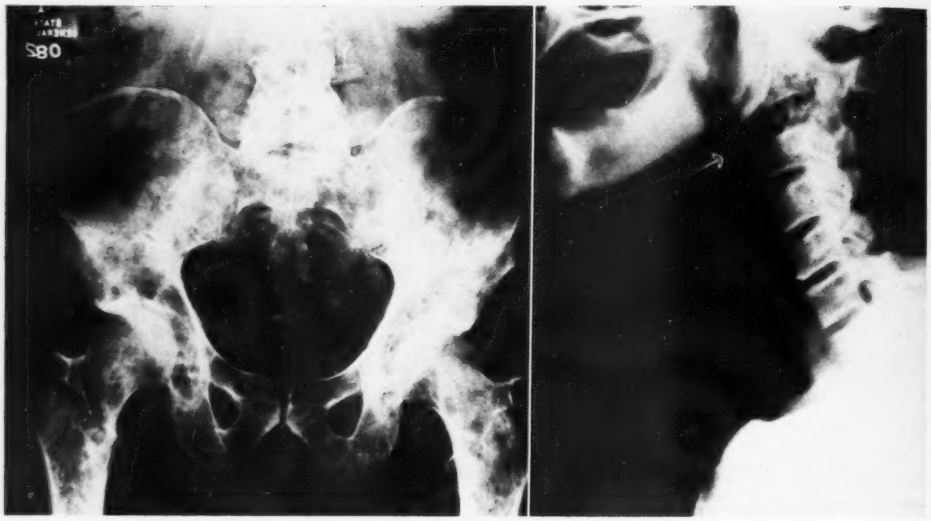

Fig. 5. Fig. 6.

Fig. 5. Case 2. Appearance of pelvis after generalization had occurred (20 months after onset of symptoms). There are multiple "punched-out" defects throughout the pelvis and upper femora characteristic of multiple myeloma.

Fig. 6. Case 3. Appearance of cervical spine at time of first admission. The body and spinous process of C3 are almost completely destroyed. The articular masses are partially preserved.

the adjacent ones were intact, however. In the anteroposterior view a small soft-tissue shadow could be seen on the left side of the tenth dorsal vertebra. The tumor was thought to be malignant but, other than this, no statement as to its nature could be made (Figs. 3 and 4). Roentgen examination of the chest, spine, pelvis, ribs, skull, arms, and thighs revealed no other foci.

One examination of the urine for Bence-Jones protein was negative. Laminectomy was done and tumor tissue encountered. The pathologic diagnosis was plasma-cell myeloma.

On May 4, 1936, roentgen deep therapy was started, 200 r being given on successive days to a single field directly over the lesion for a total dose of 1,200 r. He returned on July 14, 1936, reporting improvement in his symptoms. Five daily doses of 200 r were given to the same area. Improvement continued and on Dec. 31, 1936, he was able to walk with the aid of only a cane. Roentgen examination revealed a lesion in the anterior arc of the left third rib and this was treated with six daily doses of 200 r each. He was again admitted to the hospital on April 14, 1937, and roentgen examination of the skeleton showed typical multiple myeloma involving the ribs, spine, pelvis, femora, and skull (Fig. 5). His condition rapidly grew worse and he died on April 24, 1937. Postmortem examination confirmed the x-ray findings of multiple myeloma which was considered at this time to be, histologically, of the myelocytic type.

Case 3 (J. F.). The patient, a colored male, aged 60, was first admitted to the hospital on Sept. 13, 1937, with a chief complaint of pain and stiffness in the back of the neck of seven months' duration. For the past three months the pain had radiated down the right arm and this arm had become weak. Tingling sensations and numbness had developed and, more recently, there had been noted increasing weakness of the legs. Physical examination and the neurologic findings indicated a lesion involving the cord in the lower cervical area. Tests for Bence-Jones protein

Fig. 7.

Fig. 8.

Fig. 7. Case 3. Appearance of cervical spine 19 months later. The laminæ of the third, fourth, and fifth vertebræ were removed at operation. The disease has extended to involve the second and fourth cervical vertebræ, with complete disappearance of the third and with considerable shortening of the cervical spine. In spite of local extension, the patient had remarkably few complaints.

Fig. 8. Case 4. Destruction of the right sides of the bodies and laminæ of the first and second dorsal vertebræ. Slight soft-tissue shadow adjacent.

in the urine gave a faint positive reaction once and were negative on other occasions. Roentgen examination revealed extensive destruction of the body of the third cervical vertebra with disappearance of its spinous process. The lamina was involved but sufficient of the articular masses remained to give some support posteriorly (Fig. 6). Operation was done on Sept. 25, 1937, with removal of the laminæ from the second to the fifth cervical, inclusive. A tumor mass was encountered involving the laminæ of the second and third cervical vertebræ and invading the soft tissues. Histologic diagnosis of the material removed was plasma-cell myeloma. Roentgen therapy was begun on Oct. 7, 1937, eight daily doses of 200 r each being given to the right and left cervical region. On Dec. 28, 1937, a second series was commenced, 1,400 r being given to one posterior field in daily fractions of 200 r. By this time some improvement was noted in symptoms and physical findings. On Sept. 15, 1938, the patient was re-admitted for further observation. Clinically he was much improved but roentgen examination showed extension of the disease to the fourth cervical vertebra and enlarged lymph nodes could be palpated in the right cervical area. This region was treated through two portals with a total dose of 1,200 r to each area, in daily fractions of 200 r. At the last examination on April 10, 1939, progressive destruction of the fourth cervical vertebra was found although he was much improved symptomatically (Fig. 7). Examination of the spine, pelvis, chest, and ribs showed no new foci of the disease. Eight daily doses of 200 r each were given to the right and left sides of the cervical spine. No further follow-up was obtained.

Case 4 (I. H.). The patient, a white female, aged 54, was admitted to the hospital on Jan. 15, 1939. Symptoms had begun gradually three months before, with pain between the shoulders. Following this, her legs became so weak that she had difficulty in getting her feet off the floor. Numbness of the feet and toes was noted. On physi-

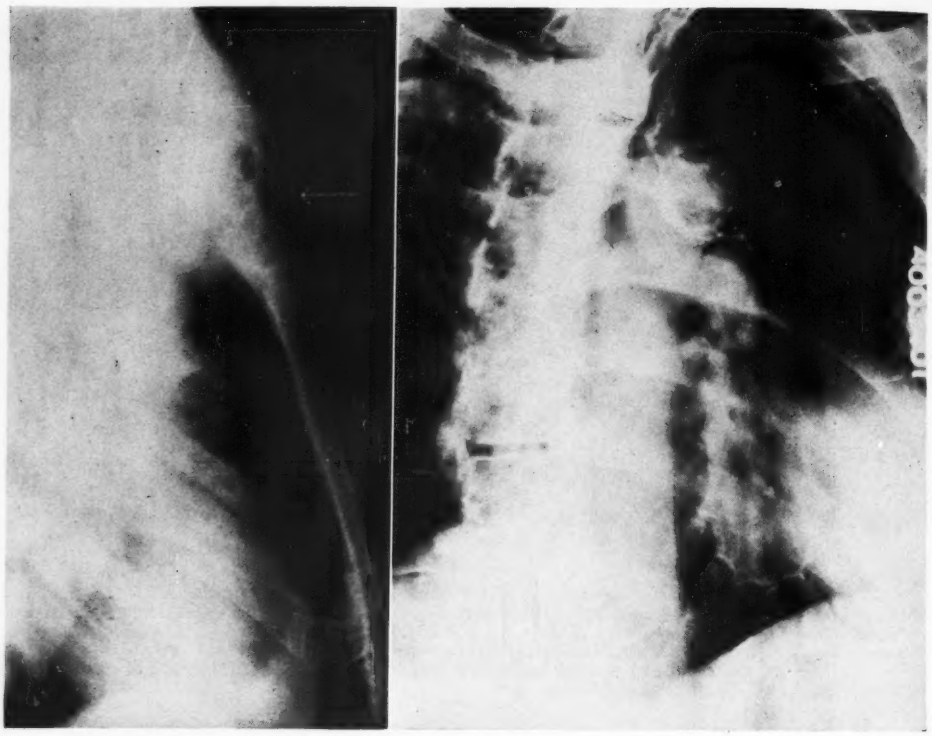

Fig. 9. Fig. 10.

Fig. 9. Case 5. Lateral view of sternum at the time of first admission. Multi-cystic osteolytic lesion involving the manubrium. Cortex anteriorly is fragmented.
Fig. 10. Case 5. Oblique view of sternum. Note multi-cystic and expanded appearance of manubrium.

cal examination the legs were hypotonic, with increased knee and ankle jerks. Abdominal reflexes were absent, the Romberg test was positive, the gait was ataxic, and there was an indefinite level of hyperesthesia on the right conforming to the tenth to twelfth dorsal segments. Routine laboratory findings were within limits of normal. The urine was negative for Bence-Jones protein.

Roentgen examination of the spine showed a destructive lesion involving the first two dorsal vertebræ. These bodies were almost completely destroyed except for the left side, where some bone structure remained. The laminæ and pedicles on the right side were included in the destructive process (Fig. 8). No lesions were found in the remainder of the spine, ribs, or pelvis.

Laminectomy was done on Jan. 24, 1939, when a tumor was found involving the laminæ of the seventh cervical and first two dorsal vertebræ. Histologic diagnosis of this tumor was plasma-cell myeloma. She was given 1,600 r to the upper dorsal area in daily fractions of 200 r. The patient was discharged from the hospital on Feb. 22, 1939, with no apparent change in her condition. On Sept. 18, 1939, she reported for observation. There had been marked improvement, she had no complaints, and was doing her own housework. Roentgen examination showed no progression of the disease in the upper dorsal spine and roentgenograms of the skull, spine, pelvis, arms, and thighs showed no other foci.

Case 5 (J. B.). The patient, a white male, aged 59, was admitted to the hospital on Sept. 13, 1938. Five or six weeks before admission he had noticed a tender

swelling over the upper sternal region, which reached its maximum size in three or four days and since then had become a little smaller. At first he had had severe pain when he took a deep breath and lately there had been a dull ache in the region of the swelling. On physical examination a mass was found over the upper end of the sternum, about 5 × 11 cm. in size, quite soft but giving the impression of being of bony hardness deeper down. The mass was not adherent to the skin. Routine laboratory studies gave essentially normal results. The urine was negative for Bence-Jones protein on two occasions. Roentgen examination of the sternum showed a multicystic-appearing area of rarefaction in the manubrium extending into the calcified costal cartilage of the first rib. Soft-tissue swelling was apparent over the lesion anteriorly. The cortex was involved and somewhat fragmented (Figs. 9 and 10). Films of the spine, pelvis, skull, and ribs showed no other foci. Biopsy of the tumor was done and the histologic diagnosis was plasma-cell myeloma. Roentgen therapy was given, eight daily doses of 200 r to a single field directly over the tumor. On Jan. 17, 1939, another series was commenced, a total of 1,200 r being given. At this time the tumor mass had decreased considerably in size, and the lesion in the manubrium showed some recalcification. Roentgenograms of the skull, pelvis, and spine showed no evidence of spread of the process. At the last examination on May 31, 1939, no further change was noted in the tumor either clinically or roentgenologically and no further treatment was given.

## SUMMARY

While the total number of cases of solitary myeloma is small, a review of those found in the literature, together with the five of our own, makes it possible to arrive at some fairly definite conclusions, as follows:

(1) While unusual, solitary myeloma of bone cannot be considered a rare disease.

(2) Pathologic reports indicate no essential difference between the solitary and multiple forms of myeloma. It seems entirely possible that myeloma may occur in varying degrees of malignancy with generalization occurring early in some (typical multiple myeloma) and late or never at all in others.

(3) Two main forms of solitary myeloma occur, according to the roentgenologic picture. In one, the resemblance to giant-cell tumor is striking. In the other, osteolysis predominates but expansion of bone may be present. While it is impossible to predict the degree of malignancy from roentgenologic examination, the trabeculated, multicystic form tends to run a more benign course. When generalization occurs, it usually assumes the form of typical multiple myeloma.

(4) Because of the possibility of a relatively benign form of tumor, strenuous efforts at eradication of the lesion are warranted. In the spine, laminectomy with removal of as much of the tumor as possible and followed by thorough irradiation, is the treatment of choice. In the pelvis and other bones inaccessible to surgery, external irradiation may result in arrest or possible cure of the disease. In the long bones, roentgen irradiation is advocated as the first measure. If this fails or the lesion recurs locally, excision or amputation should be considered.

(5) Solitary myeloma must be differentiated, roentgenologically, from giant-cell tumor, localized fibrocystic disease, metastatic malignancy, osteogenic sarcoma, Ewing's tumor and from some of the rarer tumors of bone. The age incidence, location of the lesion, symptomatology, and roentgen appearance are of aid in this differentiation. At the present time we do not believe it is possible to make an unequivocal diagnosis of solitary myeloma from roentgenologic examination alone although the probability of its existence may be correctly stated. In most instances, final proof will depend on microscopic examination of tissue, and biopsy is advocated in order that adequate treatment may be instituted.

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# MULTIPLE MYELOMA[1]

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EARLY diagnosis of multiple myeloma is frequently a difficult problem. Like other multiple osteolytic lesions, the prognosis is serious and early accurate diagnosis is important. The roentgen findings are often the only evidence of multiple myeloma, but recent authors have emphasized the frequent lack of typical x-ray findings and the close mimicry of other bone lesions. Hodges (1), describing the lesions of multiple myeloma, states that, "there is nothing definitely characteristic about their appearance." Geschickter (2) says, "in the roentgenogram it may be practically impossible to distinguish between multiple myeloma and diffuse metastatic carcinoma." Sager (3) recently presented a carefully studied case of multiple myeloma simulating hyperparathyroidism that was determined only at biopsy. The typical case of multiple myeloma presents a fairly obvious picture but there are so many variants from the usual and lesions may be so closely simulated by other pathology that diagnosis from clinical and laboratory methods may be obscure if not impossible.

The lesions of multiple myeloma are malignant osteolytic tumors arising from cells in the red bone marrow. They have no relation to the osteogenetic cells and hence do not produce bone. By the time the lesions are sufficiently large to give x-ray findings, they are generally multiple in the involved bone and usually occur in several locations. The lesions in the early stage are, as a rule, limited to the bone and often there is no palpable tumor or swelling. Four definite types of myeloma are recognized by the Registry of the American College of Surgeons (4), depending on the predominant type of marrow cell found in the lesion, namely, the plasma cell, myelocyte, erythroblast, and lymphocyte. However, this classification has no clinical significance. The gross pathology and the clinical course of these four types of the myeloma series are similar and cannot be differentiated except by microscopic study. The plasma-cell myeloma is the type generally found.

As the disease progresses the lesions in any one bone increase in size and number and there is usually an increase in the number of bones involved. There is no evidence that these lesions are metastases but they are probably independent lesions. However, myeloma does metastasize to the soft structures and typical lesions have been found in the liver, spleen, and lymph nodes. Occasionally metastatic glands are found before bone lesions are large enough to be demonstrable (2). Metastases have not been found in the lung-fields except in the case reported by Wieland.

While there are no characteristic symptoms of multiple myeloma, the most usual symptom is pain in the lumbar region or chest. The pain may be mild until some minor injury precipitates a fracture or the crushing of a vertebra, and it may be shifting and intermittent. It may be insignificant until after the bone lesions are well advanced, or it may be intense and severe before the lesions can be shown on the roentgenogram. The presenting symptoms may in no way point to the disease and may be those of chronic sinusitis, gastric hemorrhage (5), acute pleurisy, or herpes zoster, or there may be an entire absence of early symptoms, as seen in Case 1 reported herein.

Since the first case of multiple myeloma was described by Watson, MacIntyre, and Dalrymple ninety years ago, it has been associated with the finding of Bence-Jones protein in the urine and this proteinuria has been thought to be characteristic of the disease. The presence of Bence-

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

Jones bodies in the urine occurs in from 50 to 65 per cent of myeloma cases but it is not pathognomonic. Bence-Jones bodies are formed in the bone marrow and they may appear in the urine in any disease of the marrow including metastatic carcinoma. The finding of Bence-Jones bodies does eliminate hyperthyroidism as the proteinuria is not seen in this disease. The absence of Bence-Jones bodies is not significant because they occur only intermittently in the early stages of the disease and may be entirely absent in from 30 to 50 per cent of the cases. A more constant finding in the urine is evidence of nephritis which occurs in about 70 per cent of the cases.

The blood picture is not characteristic although there is usually a progressive anemia. There may be an increase in the serum calcium but the serum phosphorus remains normal or increased. There may be a hyperproteinemia and inversion of the serum-globulin ratio but these are not constant findings and do not occur in over 50 per cent of the cases. The normal serum phosphorus and normal calcium balance are evidence against hyperparathyroidism. The presence of Bence-Jones bodies, increased serum calcium, and phosphatase does not eliminate metastatic carcinoma as they may all be present in the latter condition.

The roentgen findings will depend on the stage of the disease in which the examination is made (6). Marked pain or backache may bring the patient for study before any bone lesions are demonstrable (Case 3). Usually the patient appears several months after the onset and there are diffuse multiple bone lesions. The bones most frequently involved are the spine, ribs, skull, and pelvis. It must be emphasized, however, that lesions may be absent in any one of these locations and that myeloma cannot be ruled out because there is no evidence of disease in the skull or in the spine at the time of the examination. Case 1 showed a normal lumbar spine and Case 3 showed no evidence of pathology in the skull although there were advanced lesions in the dorsal spine at the time of the examination.

The most characteristic findings pointing to a diagnosis of multiple myeloma are small, multiple, clean-cut areas of bone destruction with the appearance of having been punched out of otherwise normal bone. The lesion is purely osteolytic and does not produce bone reaction or sclerosis. While there is union of pathologic fractures, there is no evidence of new bone on the roentgen films.

In the skull the typical sharply circumscribed lesions are usually found in the frontal or upper parietal bones. In advanced lesions these areas may coalesce and give a diffuse mottling of the skull. There is no thickening of the tables of the skull and there are not the large areas of bone destruction which may be seen in the Schüller-Christian syndrome. There is no bone reaction in the surrounding skull, such as is seen in carcinoma and syphilis, and the lesions do not tend to be irregular and infiltrating as in metastasis.

In the spine the typical, small, discrete lesions may be seen in the bodies of one or more vertebræ, but, as pointed out by Snure, there may be extensive destruction of the vertebral bodies by osteolytic lesions, presenting no x-ray evidence until the cortex is involved. The usual findings are rarefaction, with fracture or collapse of one or more bodies. As the disease progresses there may be diffuse mottling of the bodies with the loss of the usual architecture and the softening may permit of marked swelling of the intervening discs. Usually the lesions in the spine are not characteristic and present no definite findings to differentiate them from other osteolytic conditions.

In the ribs the most frequent finding is diffuse mottling and demineralization. There may be cyst-like areas of expansion with palpable tumors, or there may be complete destruction of portions of a rib. There are frequently multiple spontaneous fractures in several ribs and this finding is quite significant in pointing toward a diagnosis of multiple myeloma.

In the ends of the long bones the lesions may fuse into large cyst-like areas which simulate localized cystic osteitis. These lesions, when advanced, lead to marked bone atrophy, the cortex becomes paper-thin but with little or no expansion. Occasionally lesions in the ends of the long bones may exactly simulate the lesions of osteoclastic metastases (2), but the typical early lesions here, as elsewhere, are small discrete areas of destruction in normal bone.

Multiple myeloma may give varied and confusing secondary findings in the roentgenogram of the chest; lesions may perforate the ribs and give soft-structure tumors; spontaneous fractures of the ribs may give localized sub-pleural hematoma and develop pleural effusion or empyema. Large soft-structure tumors may arise from the posterior surface of the sternum or from the vertebræ, giving the appearance of primary mediastinal tumors. However, multiple myeloma does not metastasize to the lung-fields and this is an important diagnostic finding.

*Diagnosis.*—The probability of multiple myeloma should be considered in any adult patient who has multiple osteolytic bone lesions or multiple spontaneous fractures. The characteristic findings of small, discrete, punched-out areas in normal bone, plus a Bence-Jones proteinuria, may be found, and, if so, are usually decisive. While the usual locations are the spine, skull, ribs, and pelvis, it must be remembered that any of these areas may escape involvement and that the lesions in the spine often do not have any characteristic appearance.

Hyperparathyroidism with cystic bone changes can usually be definitely ruled out. The demineralization of parathyroid disease involves the entire skeleton (7), and cysts and tumors are secondary findings, whereas the typical findings of myeloma are discrete, clean-cut areas of bone destruction without generalized porosis. Bence-Jones bodies do not occur in hyperparathyroidism and their presence should exclude this disease. High serum calcium and secondary hyperplasia of the parathyroid glands may occur in myeloma or in carcinoma but in multiple myeloma they are not accompanied by the low serum phosphorus and the low calcium balance typical of parathyroid disease.

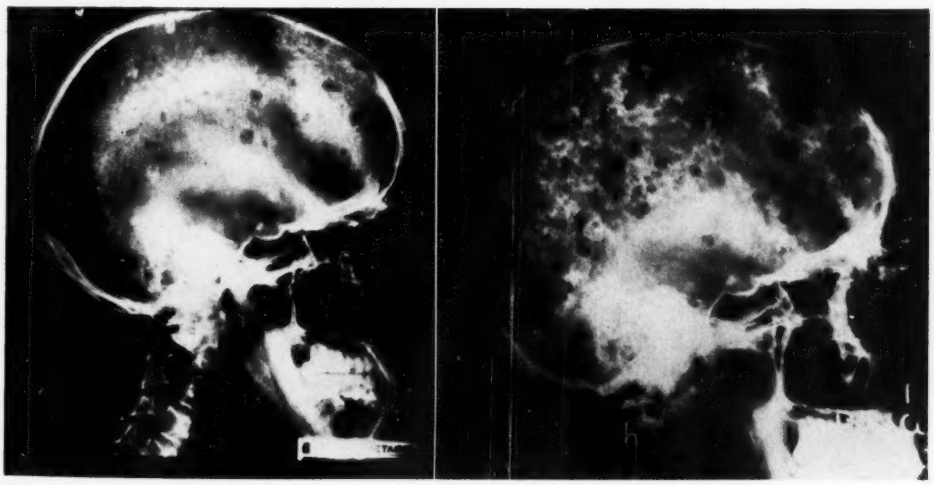

Fig. 1-*A*. Fig. 1-*B*.

Fig. 1-*A*. Case 1. No clinical symptoms, the condition was discovered accidently from albuminuria and Bence-Jones reaction. Punched-out areas in the skull were the only lesions in the skeleton.
Fig. 1-*B*. Case 1. Roentgenogram of the skull made one year after Figure 1-*A* and before the death of the patient from uremia.

The osteolytic type of metastatic carcinoma closely simulates multiple myeloma and it may be impossible to differentiate between the two on the roentgenogram. Bence-Jones protein may be found in either, and the blood picture may be identical in both. However, the typical small myeloma lesions occurring in the skull can usually be distinguished from the larger, more diffuse, moth-eaten areas of metastasis. The reactions of osteitis and sclerosis, frequently seen in and around metastatic lesions, are never seen in myeloma. Multiple myeloma lesions are purely osteolytic, and osteoblastic changes will be evidence of metastases.

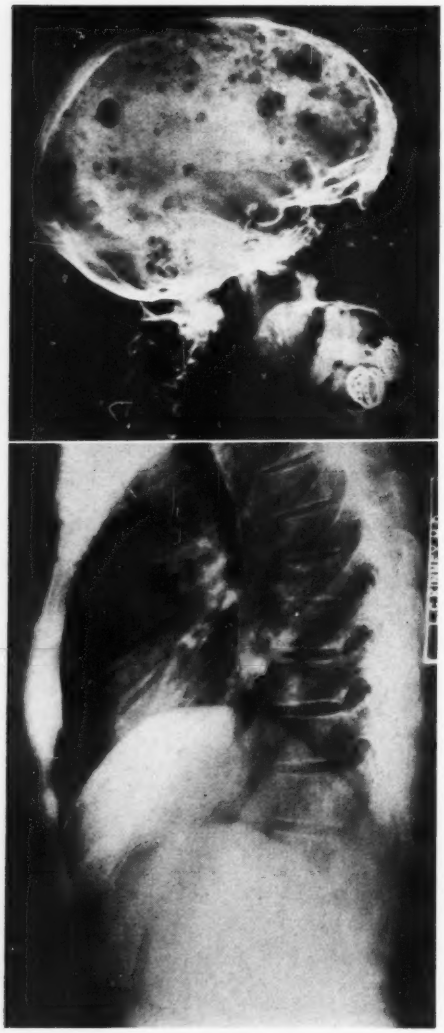

Fig. 2-*A* (*upper*). Case 2. Two "wens" in the scalp, of two months' duration, were the only symptoms.

Fig. 2-*B* (*lower*). Case 2. The lesion in the seventh dorsal vertebra was without symptoms except for transient herpes two months previously.

Paget's disease, in which the bone absorption is accompanied by simultaneous bone production and alteration and rearrangement of architecture, should not be a difficult differential problem. It is never a purely osteolytic lesion. The lesions of myeloma are never accompanied by the thickening of the tables of the skull which is characteristic of Paget's disease.

### CASE REPORTS

Case 1. H. G., male, aged 51 (courtesy A. B. Smith, M.D., La Jolla, Calif.), was admitted to the Scripps Memorial Hospital for general survey because he had been rejected for life insurance. The patient had no pain or other complaints and the medical history was not significant. On examination on Nov. 29, 1938, the blood examination was normal, blood urea 25 mg. The urine showed serum albumin 2.1 gm., and Bence-Jones protein. The roentgenograms showed no abnormal findings in the rib cage, spine, or pelvis. In the frontal and parietal regions of the skull there were typical small, punched-out areas varying from 3 to 10 cm. in diameter. There was no bone reaction around these areas and the skull was otherwise normal.

On Nov. 8, 1939, he was re-admitted with marked anemia. Hemoglobin 44 per cent; red blood cells 2,000,000; coagulation time 7.5 minutes; the blood urea had risen to 272, and there was bleeding from the gums, nose, and hemorrhoids. The roentgenograms taken at this time showed marked increase in the areas of destruction throughout the skull, the ribs showed numerous spontaneous fractures, and there was involvement of the lumbar spine and pelvis. This patient died of uremia shortly after this admission.

*Comment.*—This case showed typical

lesions of multiple myeloma without clinical symptoms. The lesions were discovered because of a nephritis and Bence-Jones bodies. There were no significant findings in the ribs, spine, or pelvis at the first examination. Later painful lesions were satisfactorily controlled by x-ray therapy. Death from uremia occurred one year after the discovery of the lesion.

Fig. 3-*A*. Case 3. Roentgenogram of the dorsal spine four and one-half years after onset of symptoms. Films made five months previously had been negative.

Case 2. R. S., female, aged 43 (courtesy James B. Bobbitt, M.D., San Diego, Calif.). The medical history was negative aside from a transient attack of pain in the cervical region in 1936, which was relieved by diathermy. In February, 1938, there was a short attack of herpes zoster, following the right eighth intercostal nerve, which disappeared in three weeks without residual pain. At this time two small lumps were discovered in the scalp and were considered to be wens. In April, 1938, the patient consulted her physician for removal of the wens. Aside from slight pain in the cervical region, there were no other symptoms and the patient was in good physical condition. The x-ray examination showed that the scalp tumors involved the entire thickness of the skull and that there were multiple small, punched-out areas throughout the skull. The dorsal spine showed slight compression of the bodies of the seventh and eighth vertebræ and there

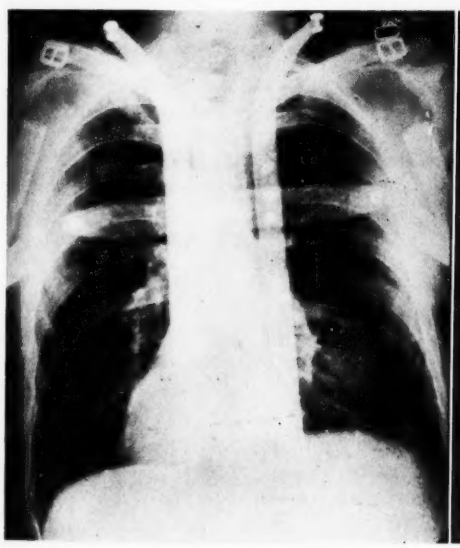

Fig. 3-*B*.

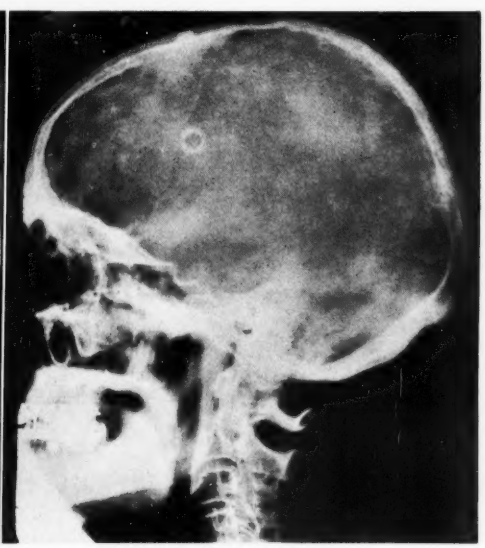

Fig. 3-*C*.

Figs. 3-*B* and 3-*C*. Case 3. Films of the skull and skeleton, except the spine, remained negative until the time of death, which occurred five and one-half years after onset of symptoms.

were numerous small, discrete areas of bone absorption in the bodies. The manubrium of the sternum showed numerous small areas of destruction and a soft-structure tumor extending about one centimeter posteriorly. There were also minute lesions in the anterior arch of the pelvis and the upper third of the femora. The urine showed Bence-Jones bodies. The patient died four months after the discovery of the lesion. During the last three weeks there was the typical agonizing terminal pain.

*Comment.*—The only leading clinical symptom in this case was the presence in the scalp of soft-structure tumors having the appearance of wens. The case was far advanced before there was any significant symptom to point to bone disease.

Case 3. G. U., male, aged 56 (courtesy C. L. Stealy, M.D., San Diego, Calif.), had complained of backache in the lumbar and lumbosacral regions for four years. There was nothing significant in the medical history and the physical examination, when the patient was first examined in Cleveland, on May 22, 1935, was negative except for restriction of movement in the lumbar spine. There was no evidence of bone disease on the films made at that time. There were remissions and relapses in the pain in the lumbar region until Sept. 12, 1935, five months later, when there was a sudden, painless hematuria. Films of the dorsal spine at this time showed a marked demineralization of all the bodies with expansion of the intervertebral discs and some compression of the eleventh dorsal vertebra. There was a marked anemia. Hemoglobin 54 per cent, with 5,000,000 red blood cells, which did not respond to liver medication or transfusion. Blood calcium, phosphorus, and phosphatase were normal but there was inversion of the albumin-globulin ratio and Bence-Jones proteinuria. A biopsy of the sternum bone marrow was not significant. There were no demonstrable discrete, punched-out areas in any of the regions studied and the skull showed no evidence of pathology. One year later, when examined in San Diego, the roentgenogram showed no lesions except in the spine. The autopsy, performed on Nov. 12, 1936, showed no changes in the skull. The sternum and ribs were fragile, the marrow greatly increased in amount, and the cortex in many areas was paper-thin. There were no isolated bone tumors. The dorsal and lumbar vertebræ were decreased in vertical diameter. The organs of the thorax, abdomen, and pelvis were negative. The microscopic diagnosis was myelomatosis.

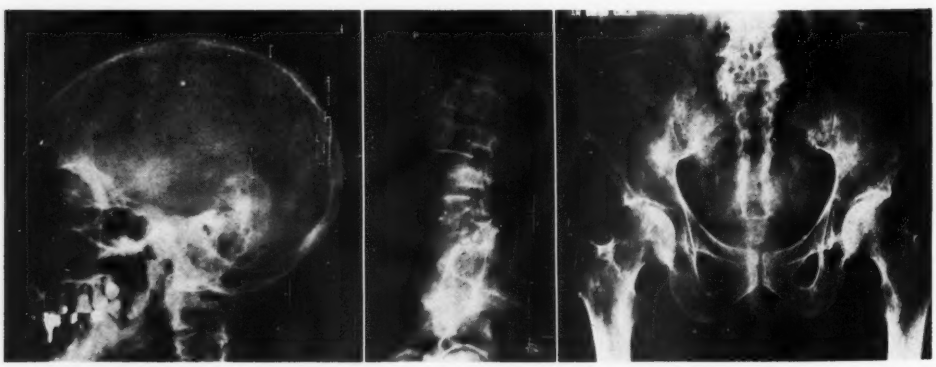

Fig. 4-*A*. Fig. 4-*B*. Fig. 4-*C*.

Figs. 4-*A*, 4-*B*, and 4-*C*. Case 4. There had been symptoms of backache for six months and history of minor injury one month previously, as well as acute vomiting. Hyperparathyroidism was considered because of diffuse rarefaction in the spine, pelvis, and skull, high serum calcium, and tumor in the thyroid. Autopsy showed multiple myeloma.

*Comment.*—This patient had clinical symptoms for four years and at the end of that time the only demonstrable x-ray findings were in the dorsal spine, there never being any in the skull or other bones. There were no discrete, punched-out areas demonstrable at any time. The autopsy showed multiple myeloma limited to the spine and the bones of the trunk.

Case 4. J. F., male, aged 56, had complained of vomiting, pain in the back and hip, and weakness. The severe pain followed a chiropractic adjustment one month previously. Vomiting was of two days' duration, while the backache had lasted about six months. Physical examination was negative, except for tenderness of the third and fourth lumbar vertebræ and the lumbosacral region. There was a hard nodule in the upper portion of the left lobe of the thyroid. Blood showed a moderate anemia, serum calcium varied from 14.8 to 20 mg., phosphorus 3.2 mg., urine showed Bence-Jones protein. X-ray examination showed demineralization of the lumbar bodies and of the sacrum, with mottling and compression of the second and fifth bodies. There was widening of the discs. The skull showed small scattered areas of bone absorption. Because of the diffuse rarefaction in the skull, spine, and pelvis, the high calcium, and the tumor in the thyroid region, the case was considered one of hyperparathyroidism. Operation, performed on Feb. 7, 1936, showed a large adenoma in the left lobe of the thyroid with no enlargement of the parathyroids. The patient died on March 18, 1936, following bronchopneumonia. Autopsy showed multiple myeloma involving the skull, ribs, and spine. The pancreas was hemorrhagic and firm but otherwise the visceral findings were normal.

*Comment.*—The presenting symptom in this case was vomiting and intense disability following a minor injury. The discrete, clean-cut, punched-out areas in the skull, Bence-Jones proteinuria, and normal serum phosphorus were overlooked in favor of the diffuse rarefaction in the spine and pelvis, high serum calcium, and the tumor in the thyroid region, in reaching a diagnosis of hyperparathyroidism.

## SUMMARY

Multiple myeloma has no characteristic symptoms of onset and no definite early clinical picture. Bence-Jones proteinuria and evidence of kidney damage occur in a large percentage of cases but these findings are not pathognomonic and may be absent, intermittent, or occur only late in the disease. The roentgen appearance of small, clean-cut, destructive lesions in otherwise normal bone is the most characteristic finding pointing to a diagnosis. However, this characteristic finding is often not demonstrable. There may be no evidence of bone lesions in the very early cases, and when they do occur they may present variations exactly simulated by other osteolytic lesions. Some myeloma cases never show lesions in the skull and, consequently, the absence of skull lesions is not significant in ruling out myeloma.

The lesions of multiple myeloma are seldom solitary in one bone or limited to one bone. The discovery of multiple osteolytic lesions in any bone or of any destructive lesion in the spine should immediately raise the question of multiple myeloma. Examination should then be extended to include x-ray studies of the skull, the entire spine, ribs and sternum, and of any painful areas in the extremities.

If there are typical, sharply etched, destructive lesions in otherwise normal bones, their presence will point to a diagnosis. However, if the lesions are not characteristic they must be differentiated from metastatic carcinoma, parathyroid disease, and other osteomalacia. After the character and geography of the lesions have been demonstrated it may be possible to discover a primary carcinoma as a probable source of the osteolytic lesions. If so, this will simplify the diagnosis, particularly if there are any osteoblastic changes or reactive osteitis. On the other hand, the osteolytic lesions may be accompanied by diffuse skeletal granular porosis and by

faulty calcium and phosphorus metabolism typical of parathyroid disease.

In the absence of primary carcinoma or of unquestionable generalized porosis and clinical findings of hyperparathyroidism, all multiple, purely osteolytic, bone lesions must be considered to be multiple myeloma. The final diagnosis may require biopsy and microscopic examination. The biopsy is indicated if there is any question of multiple myeloma and is frequently the only means of reaching an early accurate diagnosis.

1831 Fourth Avenue

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## DISCUSSION

JOHN D. CAMP, M.D. (Rochester, Minn.): There is little that I can add to Dr. Kinney's and Dr. Paul's comprehensive considerations of this subject.

I think my experience with the differential diagnosis of multiple myeloma parallels quite closely that of Dr. Kinney in regard to metastases, hyperparathyroidism, and one more condition I would like to emphasize, called "senile osteoporosis." This condition occurs in the age group in which myeloma and multiple metastases are extremely common, and, in our experience, sometimes a diagnosis can be made only after resort to biopsy.

I know of no characteristic roentgenographic picture which will permit an unquestioned diagnosis of multiple myeloma. I agree with Dr. Kinney that all the findings he enumerated are suggestive, but to say that this is myeloma and that is metastases I do not think is always possible.

There are two things which I think may help in the differential diagnosis of these conditions. First is the presence of a high proteinemia in the blood, and the second is a sternal puncture. Snapper has emphasized the value of a sternal puncture and in cases which he has reported recently, myeloma cells were found in the sternal puncture material even when roentgenograms of the sternum were negative. All of his cases of myeloma showed a positive sternal puncture.

In regard to the solitary form of multiple myeloma, all the cases I have been concerned with have sooner or later developed multiple lesions.

There is one interesting point which Dr. Paul brought out—the age incidence. The age group seems to be lower than that for multiple myeloma.

Dr. Paul mentioned one point which I perhaps misunderstood. If I did not, I would like to disagree with him. That is about the extension of multiple myeloma or solitary myeloma of the vertebra through or across the intervertebral disc. I do not believe multiple myeloma goes across the disc; I think it goes around it. So far as I know, malignant disease does not traverse joint spaces; it extends around by way of contiguous osseous or soft-tissue structures. It may sometimes give the appearance of having gone through the joint, but, actually, in postmortem specimens, you can see that the cartilage in these cases is very much intact.

RALPH E. MYERS, M.D. (Oklahoma City, Okla.): Dr. Paul's paper has been especially interesting to me because his excellent description of solitary myeloma seemed like a portrayal of a case of mine.

My patient, a man 38 years old, first came to me in the Summer of 1931. He had a large, lobulated, destructive tumor

of the sacrum which, according to the roentgenograms, had shown little change during the previous five months. This growth must have started during 1930, or even earlier.

The films of this case were presented before Dr. Bloodgood's bone tumor clinic at the St. Louis meeting of this Society in 1931. The consensus of opinion was that it was a giant-cell tumor and that it should be irradiated. This advice was followed almost too enthusiastically, but, in spite of skin changes which threatened for a time to be troublesome, no regeneration of bone or other evidence of improvement was noted.

As a result of the destruction of the sacrum, the spine gradually settled into the pelvis for a short period of time. After three or four years the patient adjusted himself to his disability sufficiently to take care of his business as an oil driller. He thought he was improving.

In May, 1938, he returned for examination, complaining of some new symptoms which had been troubling him in varying degrees for several months. He was quite perceptibly shorter in stature than before. Roentgen examination showed the characteristic moth-eaten appearance of his skull and ribs and of some other bones. The bodies of three vertebræ were crushed. Examination of his urine revealed the presence of Bence-Jones bodies and so much albumin that it boiled solid.

Roentgen therapy was applied over his spine and ribs in an attempt to relieve pain and soreness. If anything, it did more harm than good. He became bedridden for a considerable length of time. A few months ago his wife reported that he was much improved and trying to take care of his business.

In this case the disease has been in existence for a period of eight or nine years. It would appear that radiation therapy exercised no favorable influence upon it.

LESTER W. PAUL, M.D. (*closing*): Concerning the extension of myeloma across intervertebral discs, I think Dr. Camp probably is correct. However, roentgenologically, since we see the discs only inferentially, if the adjacent bones are destroyed, the appearance is that of extension through the disc.

I think an important feature, therefore, is that this type of extension, whether it occurs around the margins or through the disc, is certainly more commonly seen in myeloma than in metastatic carcinoma.

# INTRA-ORIFICIAL ROENTGEN THERAPY[1]

## IMPROVEMENTS IN APPARATUS

*By* W. WALTER WASSON, M.D., JOHN S. BOUSLOG, M.D., *and* A. P. JACKSON, JR., M.D., *Denver, Colorado*

INTRA-ORIFICIAL x-radiation is not a new procedure and we do not wish this paper to appear as an attempt at priority as we do not have the full and complete information on the originators of the more recent developments. This method of x-radiation has been attempted for many years and has made considerable progress since the advent of shock-proof therapy units. Many cones and specula have been devised and used, including the modified Ferguson speculum used by Merritt and the expanding speculum used by Erskine. The periscope and shock-proof equipment have greatly advanced x-radiation. The improvement in apparatus which we wish to offer consists essentially of using only one cone at the time of therapy, which may be applied with precision directly to the lesion or region to be treated and checked during treatment by means of a periscope. The ability to do this with ease is accomplished by using an eye piece adjusted to fit the cone and with air compression inside the orifice. X-radiation may in this way be applied and repeated with accuracy and ease. Figure 1 shows cylinders, eye piece, and adapters used for intra-orificial x-radiation. The obturators are shown within the cylinders.

*Carcinoma of the Cervix, Vaginal Wall, and Parametrial Organs.*—In the intravaginal treatment of carcinoma of the cervix, vaginal walls, and parametrial tissues, we use varied sizes of cylinders from two to four centimeters in diameter with either a diagonal or straight tissue extremity. These cylinders are chrome-plated and opaque to x-ray in order to limit or entirely exclude radiation upon the vaginal walls. The size cylinder used depends upon the adaptability of the vaginal canal to the cylinder and on the size of the lesion or region to be treated. All these cylinders have been fitted with obturators which facilitate ease and precision in the insertion of the cylinder into the vagina. By means of an especially made adaptor ring for each cylinder an ordinary proctoscopic eye piece with light and air compressor is readily available. Figure 2 shows eye piece, adaptor ring, and cylinder disassembled. The use of air inflation in the vagina in attempting to place the cylinder accurately over the lesion or region to be treated is invaluable in exposing the cervix, displacing pouching vaginal and rectal walls and insures accuracy in fully visualizing the lesion. Figure 3 shows cylinder, eye piece, adaptor ring, and air compressor assembled. In Figure 4 is shown the periscope, developed by others, which accommodates each cylinder and connects it rigidly to the tube head following application of the cylinder to the lesion.

In treating a cervical lesion, the patient is placed in the lithotomy position on any table which is fitted with stirrups. The vaginal canal is cleansed by any one of the accepted methods and any discharge or blood is carefully mopped from the cervix and the vaginal canal. The proper sized cylinder with obturator, following lubrication, is carefully introduced into the vaginal canal and the obturator withdrawn. Caution should be used in order to prevent trauma to the tissues. The proctoscopic eye piece and special adaptor ring are now fitted snugly to the cylinder and the eye piece lighted by means of rheostat control. If the cervix is not clearly visualized following this procedure, air may be inflated into the vagina through the eye piece in the same manner in which the rectum is inflated by means of the proctoscope. By this means the pouching vaginal

[1] Presented before the Midsummer Radiological Conference in the Rocky Mountains, Denver, Colo., August, 1940.

and rectal walls are adequately displaced so that the cervix may be readily visualized. In our experience this method is much superior to other methods for the visualization of the cervix. Considerable freedom of motion is allowed the cylinder in the vagina and the area to be treated can be selected with ease by simple and careful manipulation of the cylinder. When the area to be treated is selected and localized at the opening of the cylinder, the eye piece is gently removed. This allows the air to escape, but the pouching walls of the rectum and vagina are now displaced by the walls of the cylinder.

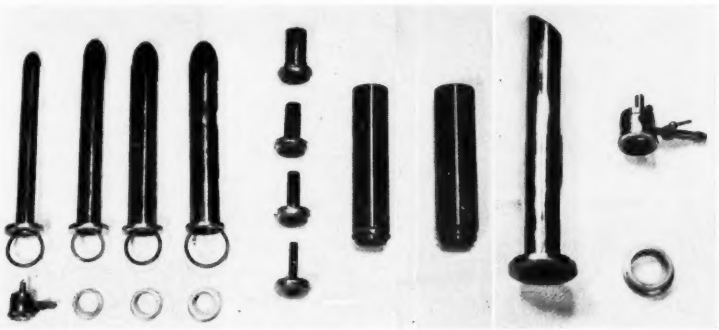

Fig. 1. Fig. 2.

Fig. 1. Assortment of cylinders, obturators, adaptors, and the eye piece used in intra-orificial x-radiation.
Fig. 2. Cylinder, eye piece, and adaptor ring unassembled.

The procedure is without any discomfort to the patient. While an assistant firmly holds the cylinder in place, the tube head with the periscope attached is brought into position and firmly clamped to the cylinder head. The periscope is seen in Figure 4. All movable parts of the machine are tightened and the cylinder is held firmly in place. A glance through the periscope enables one to determine if the position of the cylinder is as desired and treatment may be begun. The area may be checked several times during the treatment, but this is seldom necessary since there are no movable parts except the patient. Figure 5 shows tube head with periscope and cylinder in place. With the above apparatus voltages are now available from 50 to 200 kv. and any combination of filters desired may be used.

Our present method of treating carcinoma of the cervix with the above described apparatus is to treat from one to five different areas intra-vaginally, depending upon the extent of the lesion. These are supplemented by pelvic portals when indicated. Figure 6 shows the relationship of the intra-vaginal portals to each other and to the adjacent organs, frontal and sagittal views, and as seen through a vaginal speculum. From the diagram it will be seen that Area 1 may be used to treat the entire cervix and lower part of the body of the uterus; Area 2, the anterior lip of the cervix, the mid-portion of the body of the uterus, or the floor of the bladder; Area 3, the left half of the anterior and posterior lips of the cervix and the left broad ligament. Area 4 may be used to treat the posterior lip of the cervix, tissues between the body of the uterus and rectum, and the rectal wall, while Area 5 may be used to treat the right half of the anterior and posterior lips of the cervix and the right broad ligament. From the above procedure we believe we have the following advantages to offer.

While the field of the singly treated area is small compared, for example, to that of the expanding speculum, accuracy in placing the cylinder is assured and there is

little risk that a small region of the lesion will not be covered. Parametrial involvements may likewise be adequately treated

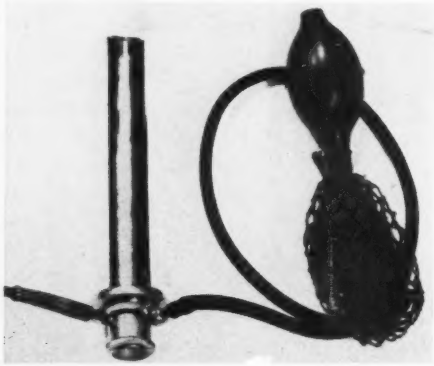

Fig. 3. The cylinder, eye piece, and air compressor, assembled.

at any desired voltage and r unit dosage. Extra-vaginal pelvic portals may also be used as indicated.

Bacterial infection is almost constantly associated with cervical carcinomas especially after they have begun to ulcerate. In most cases, however, the infection causes relatively few serious complications if treatment is instituted against the infection itself as well as against the carcinoma. With this method of repeated x-radiation with no great destruction of tissue, infection may be controlled.

*Tumors of the Rectum and Sigmoid.*—X-radiation to tumors of the rectum and sigmoid is quite as easily carried out by the intra-orificial method as with the cervical lesions. The base of a polyp which has been surgically removed from the rectum or sigmoid or other cancerous lesions may be treated in a manner similar to that described for carcinoma of the cervix. Figure 7 shows diagrammatically a lesion of the rectum and the areas treated. An ordinary proctoscope may be easily modified in such a way that the head may be fitted into the periscope. The method for x-radiation to the lesion is practically identical to that given for carcinoma of the cervix, with variations according to the type and extent of the lesion. The method is sufficiently accurate to enable the radiologist to treat the areas involved directly or in a clockwise manner. Supplementary

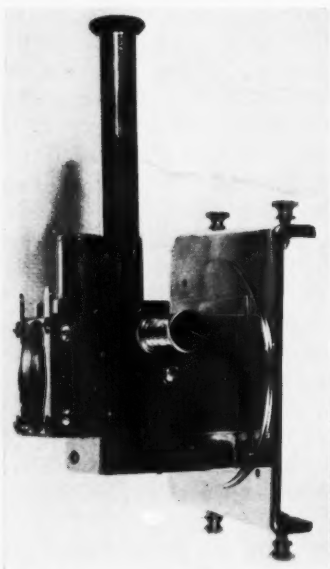

Fig. 4.

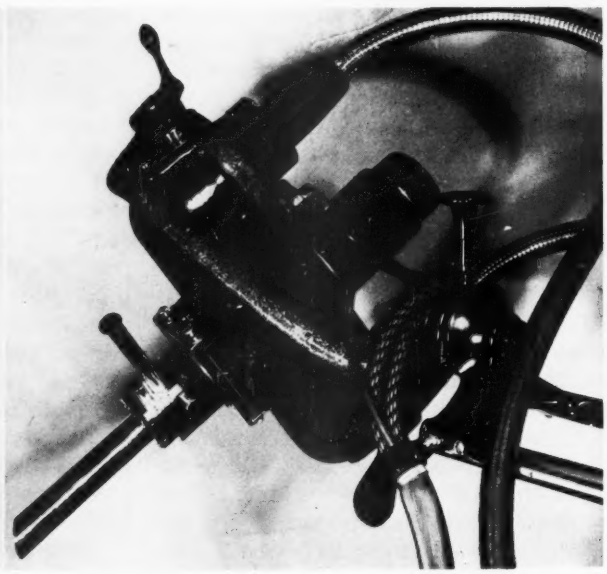

Fig. 5.

Fig. 4. The periscope showing base for attachment to tube head and the receptacle for the cylinder.
Fig. 5. Showing the cylinder and periscope attached to the tube head.

x-radiation to the lymphatic areas through abdominal and pelvic portals may be subsequently carried out.

rator, eye piece, and air compression. When this cylinder is placed and attached to a periscope and to any shock-proof unit,

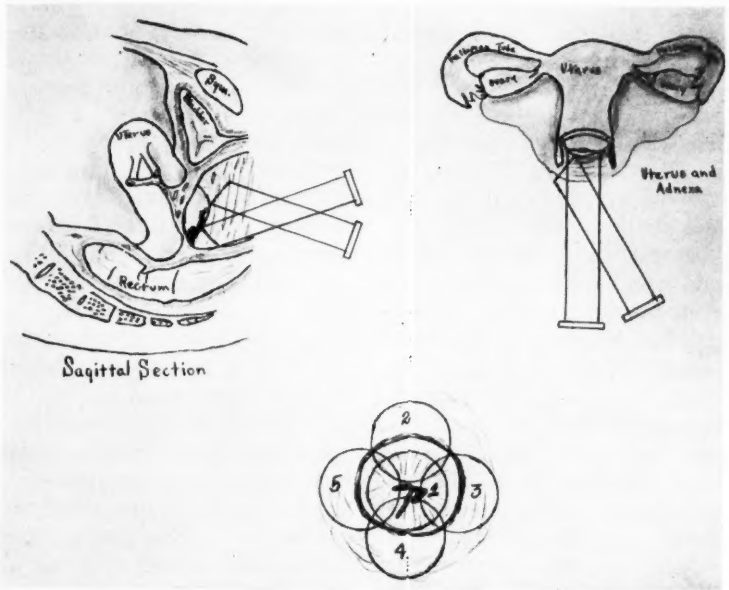


Fig. 6. A diagrammatic sketch showing the relationship of the cylinders to the areas treated and the uterine adnexa. The lower diagram shows the areas treated as they would be seen through a speculum.

It should be quite obvious that this type of procedure is applicable to the treatment of any lesion in any body orifice which will permit the introduction of a straight cylinder or speculum. The periscope is an invaluable adjunct to this type of therapy since it permits accurate localization of the lesion. Although we have had no occasion thus far to use it in the larynx or esophagus, it should be a relatively simple and effective method of therapy if suitable cylinders and obturators are available. On numerous occasions in the operating room we have employed this technic of radiation in carcinoma of the bladder through the opened bladder wall. If the bladder is left open for two or three weeks, the treatment may be repeated several times until a sufficient dosage has been delivered to the lesion.

Any contribution we have made is of the nature of a suggestion as to the use of a single treatment cylinder with obtu-

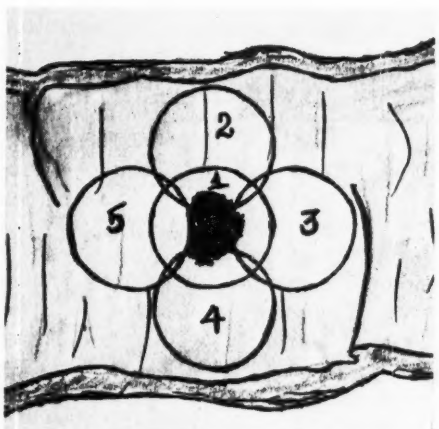


Fig. 7. Diagrammatic sketch of a lesion of the rectum with a suggested procedure of treatment in the clockwise manner.

any voltage from 50 to 200 kv. may be employed at any desired r unit dosage. In our hands the method appears to be simple and precise.

# THE VALUE OF DIAGNOSTIC CRITERIA FOR THE CHOICE OF THERAPEUTIC PROCEDURE IN THE MANAGEMENT OF ACUTE INTESTINAL OBSTRUCTION: EXPERIMENTAL AND CLINICAL OBSERVATIONS[1]

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ROENTGENOLOGY has played a most significant rôle in the accomplishments of surgery. In visceral surgery, of the abdomen and thorax, the surgeon has become especially dependent upon information revealed by roentgenograms. The plate-reading room of the roentgenologist has become the informal consulting center for the surgeon, where both negative and positive roentgen findings are sought eagerly, and efforts are made at fusion and synthesis of factual data relating to obscure cases. In the proper interpretation of the significance of intestinal distention, the roentgen findings afford most helpful assistance, so useful, in fact, that this source of factual information must never be neglected by the clinician.

I make no apologies in presuming to discuss before a body who considers its chief function the recognition of clinical disorders, the rôle of diagnostic criteria in the choice of therapeutic procedure in the management of a disorder. Preoccupied as you may be with the detection of the presence of bowel obstruction from the roentgen findings, I cannot believe that you are wholly uninterested in knowing how your decisions may influence what is done for the patient The responsibility between diagnosis and therapy is interlocked so intimately that a surgeon cannot say, "my interest concerns therapy alone"; nor a roentgenologist affect to affirm that his province is solely diagnosis and that his responsibility ceases therewith.

In part, surgeons have become physicians within certain precincts of their own province, and the science as well as the art of surgery has become improved thereby. Skillful operators, untutored in the broader outlines of the problem presented by bowel obstruction, have made no contribution to the surgery of its relief. Roentgenology embraces the whole field of diagnostic medicine, employing many technics but essentially one diagnostic agent. Yet, the implications of your judgments permeate the province of therapy so obviously that of necessity you must be interested in the choice of therapeutic procedure unless you are wholly unconcerned over the effects of your decisions. Surgeons would be the last to say that their roentgen colleagues had laid aside this responsibility. In the hospital in which I work the informal intimacy of daily contact between roentgenologist and surgeon in the consulting center of the plate-reading room, and weekly in the surgico-radiologic conference, has established an identity and unity of interest in the patient.

## THE RECOGNITION OF ACUTE INTESTINAL OBSTRUCTION

There are here and there a few who cling still to the precepts of the old school that "acute abdomen" is synonymous with the necessity for operative intervention and who are prone to regard efforts at adjudication of the nature of the ailment present as mere academic excursions into the processes of the intellect, productive of no good. The few survivors of this attitude of mind regard operation in order, always, as an agency of necessity to disclose the true character of the lesions. To operative intervention they ascribe their successes; to the disease, their failures. The inherent weakness of such logic is not difficult to detect. A much larger group, while admitting a certain virtue and value of preoperative philosophic diagnostic delibera-

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

tions, insist that operation is mandatory in all acute abdominal lesions.

In more recent years, however, a more conservative attitude of mind has developed with reference to the necessity of operative intervention. It has been shown, by proper coördination of clinical and roentgen data, that a large number of acute abdominal lesions may be identified correctly without operation. Operative intervention is rather to be determined by what may be accomplished thereby. It is to be conceded freely, however, that, now and then, operation must be undertaken as a diagnostic measure. Operative intervention which accomplishes nothing specific for the patient imposes upon him the additional burden of the hazards incident thereto.

*1. Is Obstruction Present?*—The presence of *intestinal colic*, that is, the coincident occurrence of intestinal borborygmi and crampy intermittent pain which the patient describes usually as "gas pains," determines whether or not obstruction is present. To be sure, enterocolitis and food indiscretions may be accompanied by *intestinal colic*, but on the basis of such general findings as fever, diarrhea, distention, and vomiting the distinction can be made, usually quite readily. It is to be admitted, however, that there are occasionally "spastic contractions" of the gut which mimic organic obstruction of the bowel so closely that differentiation may not be only difficult, but now and then impossible.

*2. Is the Obstruction Simple or Strangulating in Character?*—Both simple and strangulating obstructions are heralded by *intestinal colic*. Simple obstruction, being occasioned by mere interruption of intestinal continuity, is not accompanied by abdominal tenderness. In strangulating obstructions, owing to torsion or obstruction to venous outflow, sanguineous fluid escapes into the peritoneal cavity. The sensitive parietal peritoneum responds by the development of reflex rigidity, the degree of which is dependent upon the nature of the irritant. In the main, lesser grades of peritoneal irritation accompany the escape of bloody fluid into the peritoneal cavity. It is to be admitted that now and then, owing to great increases of intraluminal tension, "weeping" of the gut may occur in instances of simple obstruction with consequent exudation of fluid into the

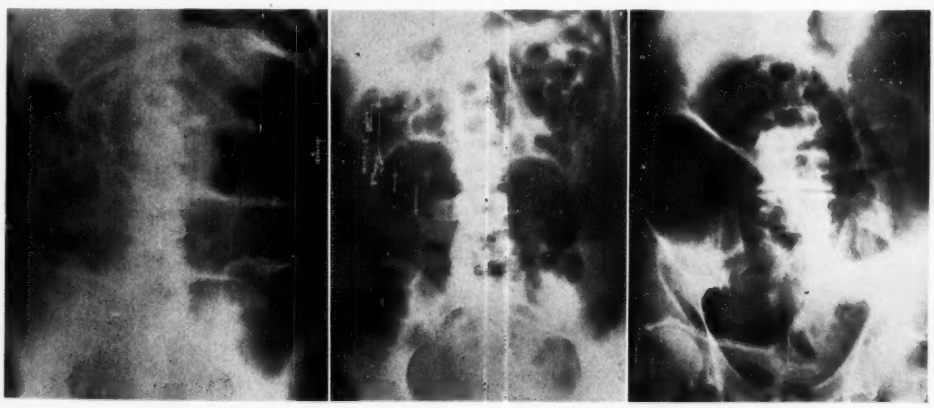


Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Scout film of the abdomen in a patient with complete obstruction of the small bowel (96 hours' duration). Recovery after enterostomy. The patient was treated in 1930; to-day, such a patient would be given a trial on suction before undertaking operation.

Fig. 2. Incomplete obstruction of small intestine. *Intestinal colic* without abdominal tenderness—an ideal case for suction.

Fig. 3. Intestinal distention in a case of obstruction of the pelvic colon by cancer. The distention is limited to the colon. There was no vomiting.

peritoneum. Instances of strangulating obstruction must, therefore, be differentiated from all acute abdominal lesions causing tenderness of the abdominal wall. The absence of *intestinal colic* in all non-obstructive lesions is of the greatest aid. It must be admitted here, however, that the distinction between a simple obstruction occasioned by an inflammatory lesion causing coincidental peritoneal irritation and a primary strangulating obstruction cannot be made oftentimes without resort to operation.

*3. Where Is the Obstruction?*—Frequent, copious emesis of feculent vomitus is the characteristic of a high grade obstruction of the small intestine. On the contrary, high grade obstruction of the colon may be unattended by vomiting and if vomiting occurs it is likely to be reflex in character, wholly lacking in the regurgitant features of the vomiting of obstruction, having its origin in the small intestine. In the experience of the writer, it may be said that stercoraceous vomiting is synonymous with obstruction of the small intestine. If a duodenal tube attached to a water siphon as a source of suction is passed into the stomach, in colonic obstruction of high grade, there may be no fluid return and if fluid is returned, it is usually observed to be colorless gastric mucus; in well established small bowel obstructions, on the contrary, a brownish fluid return is usual unless vomiting has just occurred. Early in mechanical obstruction of the small bowel, the vomitus is bilious in character. Antiperistaltic activity and the altered intestinal flora which comes with intestinal stasis causes putrefaction to occur in the upper reaches of the small bowel.

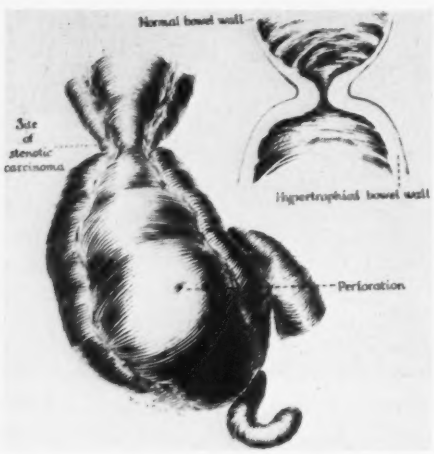



Fig. 4. Perforation of the cecum due to intraluminal tension in a patient with carcinoma of the ascending colon. Had the ileocecal valve and sphincter been incompetent, perforation would not have occurred.

### THE VALUE OF ROENTGEN FINDINGS

It is with reference to the latter point, as to where in the gut the obstruction is, that roentgen findings are particularly helpful. A knowledge of the pattern of the distribution of the coils of small bowel, described by Mall (8), lends helpful information in determining the site of obstruction in the small intestine. Knowledge of the rôle of the ileocecal valve and sphincter in preventing regurgitation of contents of the colon into the ileum makes behavior of colonic obstructions understandable. Owing to increases in intracecal pressure, the lips of the ileocecal valve are approximated, and even though fluid and gas from the proximal reaches of the small bowel may enter the cecum, regurgitation into the lower ileum is precluded.

No rule in medicine is absolute and, to be sure, there are instances in which the lower reaches of the ileum participate in the distention, when the obstruction is in the colon. This occurrence is likely to have its origin in deficiency in length of the lips of the valve, and usually the inferior lip. I am fully aware that the roentgenologist can, through the employment of abdominal palpation and the use of intra-rectal gravity inflow of barium at a meter's height, cause a reflux of barium into the ileum normally, quite regularly. However, these are grossly abnormal circumstances and the gravity pressure alone is far in excess of maximal pressures observed to obtain in instances of obstruction of the colon.

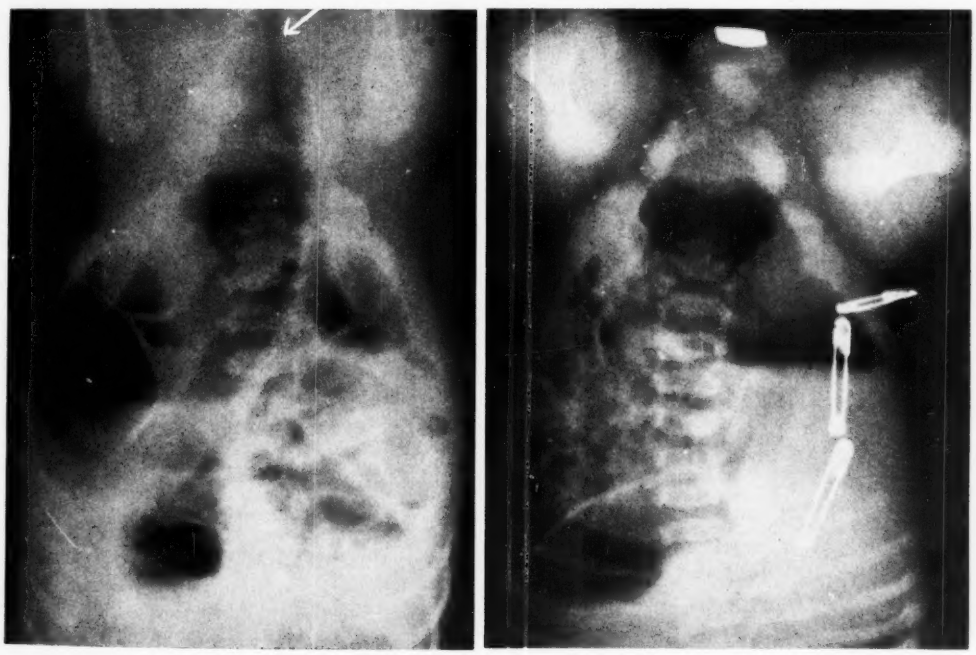
During the nine-year interval over which the writer has been alive to the competency of the ileocecal valve and sphincter in in-

stances of obstruction of the colon, nine instances of spontaneous perforation of the colon, usually in the cecum, have come to his notice. During the same interval of time, the majority of colonic obstructions have presented distention limited to the colon. There have been observed, of course, during this time, instances in which the ileum participated in the distention. Even these, however, have presented usually the clinical characters of acute obstruction of the colon referred to above.

Whereas in the infant and the young child, gas may be visualized quite regularly throughout the entire length of the bowel, in the adult, visualization of gas in the small bowel is distinctly unusual, and signifies intestinal stasis. Use of the stethoscope indicates whether that stasis has a mechanical or inhibitive (paralytic) background. It is understood now quite generally that the chief source of gas in the obstructed bowel is swallowed air.

There is another particular in which roentgen evidence is most helpful, namely, in indicating the extent to which the bowel is distended; also, in indicating whether the obstruction is complete or incomplete in nature. Great distention of itself is a fairly reliable factor, suggesting a high grade obstruction. If, however, after the administration of evacuant enemas on the ward, gas persists in the colon, in the presence of dilated loops of small intestine, this evidence would suggest the presence of a partial obstruction in which gas has filtered past the obstructive mechanism.

*1. What Films should be Made?*—With reference to the size of the intestinal coils, it is to be remembered that a scout film of the abdomen made with the patient lying supine, owing to diffraction of the x-rays, enlarges the true diameter of the intestinal coils by 25 per cent (actual measurement at operation). The diameter of a five-cent piece taped to the umbilicus is enlarged 33



*A* *B*

Fig. 5. Use of the inverted posture in detecting the extent of congenital imperforation of the anal canal and rectum. *A*, imperforation of the anal canal alone (RADIOLOGY, **17,** 54, Fig. 12-*B*, July, 1931). *B*, imperforation of both anal canal and rectum (RADIOLOGY, **17,** 55, Fig. 13-*A*, July, 1931).

per cent. When the patient lies prone, there is no enlargement of a five-cent piece taped to the umbilicus and very little of the intestinal coils. The postero-anterior film, though not giving as accurate an indication of the contour and outline of the dilated coils, gives more accurate information of the actual diameters of the distended bowel. The continuity of the dilated bowel is best traced in the anteroposterior film. In obstructions of longer standing, in which fluid accumulation within the gut may, in part, obscure the extent of the distention, films made in the sitting or erect posture will indicate by the fluid levels or mirrors, more exactly the character and extent of the distention present. In all borderline acute conditions of the abdomen, the erect film should always be made to determine the absence or presence of free gas in the peritoneum. Similarly, when the gut has ruptured, in obstruction from long sustained increases in intraluminal pressure, an erect film detects the occurrence, though visualization of the external surface of the gut made in the anteroposterior film suggests the same occurrence. The lateral or oblique views lend, occasionally, helpful information in determining which segments of gut the distention concerns. It is rarely necessary to administer barium to determine the site of the obstruction. In instances in which the feathery appearance of the valvulæ conniventes cannot with certainty be differentiated from the haustrations of the colon, and the clinical information is non-committal, it may be wise to give a little barium by rectum to aid in the differentiation. The characterless wall of the ileum can usually be distinguished with ease from both dilated jejunum and colon.

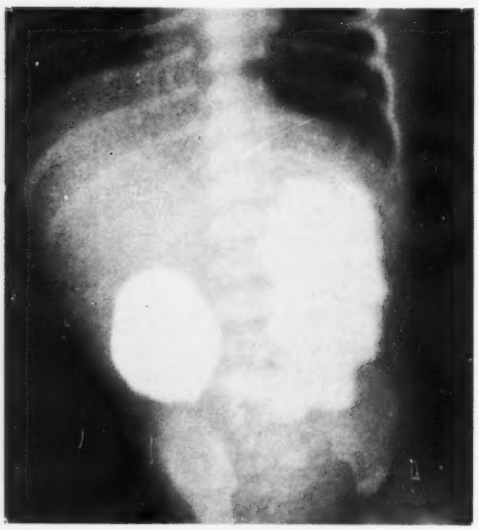


Fig. 6. Congenital atresia of the duodenum. There is no air visible in the bowel beyond the area of atresia (RADIOLOGY, **17**, 53, Fig. 11, July, 1931).

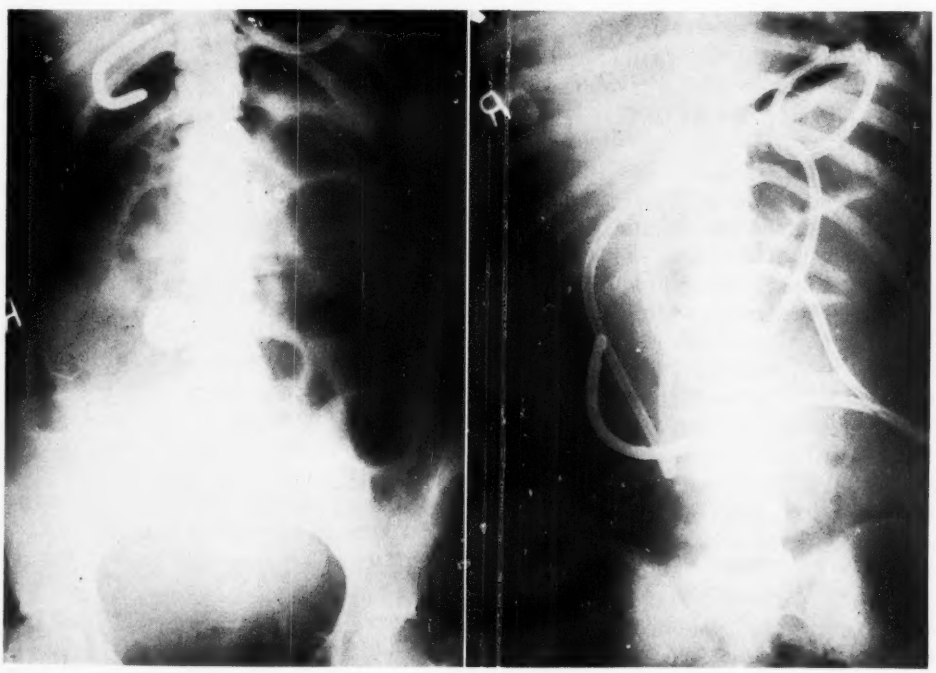
There are, of course, special uses of roentgen evidence in making the diagnosis of obstruction. The inverted or up-side-down position of the infant to detect the extent of imperforation in the anal canal and rectum is a case in point. This maneuver employed by the writer, now for more than ten years, has proved a helpful procedure in determining the magnitude of the operation necessary to reach the atresic gut (16). In atresias of the bowel in newborns, the scout film is extremely useful in determining the presence as well as the site of the obstruction. In ascertaining whether a strangulated hernia contains bowel or not, roentgen evidence gives not uncommonly useful information. Whereas the writer has employed the barium enema to reduce intussusceptions as well as to detect their presence, he has come to feel that if the clinical evidence is reliable, it is better to omit the preliminary barium study in the interest of the patient. As will be pointed out later, strangulating obstructions are attended regularly by blood loss, and unnecessary exposure and manipulations in the fluoroscopic dark room are better avoided. The surgeon may, of course, still employ gravity inflow of water to advantage on the operating table to aid in chasing the intussusception back closer to its site of origin.

*2. Can the Roentgenologist Make the Diagnosis of Obstruction without Clinical Data?*—In event the roentgenologist attempts to diagnose the presence of obstruction from the films alone without orienting

himself relative to the clinical findings, he will diagnose obstruction more often than it occurs. The findings of inter-intestinal collection of fluid as well as edema of the muscles of the abdominal wall, as described by Laurell (7), help to orient the roentgenologist. Yet, these findings are by no means reliable and are influenced by many conditions, including treatment. It is far more important for the safe management of the patient that the clinician orient himself carefully in the roentgen findings of obstruction, or, better, that he acquaint the roentgenologist with the clinical findings and that, in consequence, an intimate correlation of roentgen and clinical evidence be made. The clinician cannot disregard the importance of what roentgen observations contribute to the diagnosis. Roentgen interpretations unrelated to clinical findings are likely to be misleading.

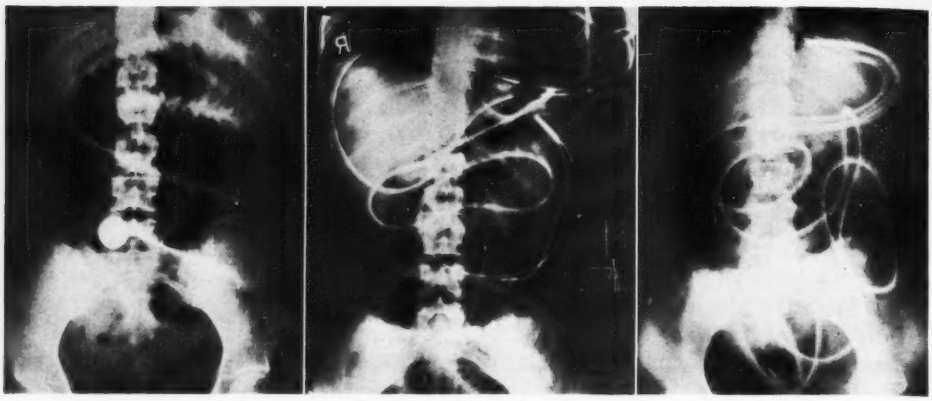
### IDENTIFICATION OF THE TYPE OF OBSTRUCTION

Whereas careful integration of clinical and roentgen data can determine (1) that bowel obstruction is present; (2) whether it is simple or strangulating in character; (3) the site of obstruction and, (4) whether it is partial or complete in character, the variety of obstruction and the exact manner in which the gut is obstructed cannot be determined short of operative intervention. In the main, however, the nature of most obstructions can be identified correctly clinically, save for such infrequent occurrences as enteric intussusceptions and gallstone obstruction. By careful integration of clinical and roentgen evidence, the difficult diagnosis of gallstone obstruction can and has been made quite early in the course of the obstruction several times in our clinic.



*A* *B*

Fig. 7. Decompression by suction applied to an inlying duodenal tube in a patient with high grade simple obstruction. *A*, intestinal distention on admission. *B*, after decompression—an ordinary duodenal tube has been well inserted into the reaches of the small intestine.



*A* *B* *C*

Fig. 8. Similar decompression, in another patient with complete ileal obstruction, employing the Miller-Abbott type of balloon-tipped tube. *A*, on admission; *B*, 24 hours later; *C*, because of recurring distention in segments of the bowel previously decompressed (*B*), it was necessary to insert another catheter into the stomach to aspirate gas and fluid as it accumulated in the upper reaches of the intestinal canal.

### THE EFFECTS OF OBSTRUCTION

Before appraising the worth of therapeutic procedures in the management of bowel obstruction, it may be well to summarize briefly the effects of obstruction. In high obstructions in which the fluid loss may be great, incident to frequent and copious vomiting, it is obvious that dehydration and dechlorination occur. These, in turn, are manifested by lowering of the plasma chlorides, elevation of the blood non-protein nitrogen, and an increase in the combining power of the blood for carbon dioxide (alkalosis). A recent study also suggests that a high grade intestinal distention may segregate blood in the lower extremities and diminish the effective circulating blood volume and thus contribute to the development of shock (3). The thesis described by Scott and the writer, in 1932 (11, 12), that blood-loss is an important factor in strangulating obstruction, has now been abundantly substantiated (2, 5, 6, 9, 10).

Apart from these systemic effects which may accompany obstruction, the most important accompaniments are effects upon the bowel wall itself. In obstruction of the small bowel, increases of sustained intraluminal pressure of 10 to 14 centimeters of water are usual. In the colon, where a short closed loop develops, owing to the behavior of the ileocecal valve and sphincter, higher pressures of from 20 to 24 cm. are the rule. If long sustained, it is obvious that the integrity of the gut wall will be threatened and a new avenue of absorption, the transperitoneal, will be opened up. When the gut becomes non-viable, whether from increased intraluminal pressure or from compromise of the blood supply, the security of the organism becomes threatened seriously. Rea and the writer (17) found that ileal obstruction in dogs was well withstood if a preliminary esophagostomy was done to obviate swallowing of air; such animals have survived complete obstruction of the terminal ileum for as long as 57 days. The small bowel, when swallowed air is excluded, can absorb its own secretions apparently. Moreover, it is even more likely that this swallowed air factor is more important in man, in whom the absorptive length of the small intestine is much greater than in the dog.

### THERAPEUTIC MEASURES OF MANAGEMENT

The liberal administration of saline solution will correct the dechlorination and dehydration of high obstruction. This therapeutic expedient does not, however, influence favorably the obstructing agency.

TABLE I.—SUMMARY OF MORTALITY OF CASES OF ACUTE MECHANICAL OBSTRUCTION OF SMALL INTESTINE TREATED AT UNIVERSITY HOSPITAL BETWEEN JUNE 1, 1931, AND JUNE 1, 1938

| | No. | No. Deaths Related to Obstruction | Percentage Mortality |
|---|---|---|---|
| All Treated Cases | | | |
| Total mortality by patients | 156 | 28 | 17.9 |
| Total mortality by cases | 190 | 28 | 14.7 |
| All Cases Treated by Suction | | | |
| Total mortality by patients | 96 | 15 | 15.6 |
| Total mortality by cases | 126 | 15 | 11.9 |
| Cases Decompressed by Suction | | | |
| Total mortality by patients | 64 | 5 | 7.8 |
| Total mortality by cases | 83 | 5 | 6.0 |

TABLE II.—PERCENTAGE OF PATIENTS TREATED BY SUCTION ALONE

| | Patients | Cases |
|---|---|---|
| Group I.—The Suction Group | | |
| (*A*) Patients in whom suction applied to an inlying duodenal tube was the only treatment directed at the relief of the obstruction (no operation). | 36.5% | 34.7% |
| (*B*) Patients decompressed by suction but operated upon subsequently because of demonstrated or conjectured persistence of obstructive mechanism. | 10.9% | 8.9% |
| (*C*) Patients in whom suction was unsuccessful in affecting decompression and in whom operation became necessary for satisfactory relief from acute obstruction. | 24.4% | 22.6% |

Total patients decompressed by suction only—47.4 per cent

Total cases decompressed by suction only—43.6 per cent.

The transfusion of blood is an important item in all strangulating obstructions in which the blood-loss factor may be serious; also in high grade obstructions, transfusion of blood or plasma and use of the dependent (Trendelenburg) posture may influence the blood pressure favorably. Increasing the blood volume will not affect the issue favorably, however, if the blood pressure drops are due to increased capillary permeability having its origin in a devitalized gut permitting transperitoneal absorption of noxious substances.

In all high grade obstructions, inhalation of high concentrations of oxygen, as described by Fine (4) and his associates, is a worth-while auxiliary therapeutic procedure. The reduction of the partial pressure of nitrogen in the inspired air to zero or nearly so, results in an effective decrease in the tension of nitrogen in the plasma. In consequence, the nitrogen in the swallowed air in the gut, despite its low coefficient of diffusibility, will be given up gradually, at the venous end of the capillaries in the gut wall and exhaled in the lungs. Without the concomitant use of suction applied to an indwelling duodenal tube, the inhalations of oxygen would by no means be so effective.

The main agency in the management of intestional obstruction, however, is decompression. The experience of the last nine years has shown that a large number of instances of simple mechanical obstruction of the small bowel can be treated successfully without recourse to operative intervention (13, 18). These constitute largely partial obstructions caused by adhesive kinks or bands. It is obvious that *all strangulating obstructions and all obstructions of the colon with great distention should be operated upon at once.* In both varieties, the viability and permeability of the gut wall are compromised by persistence of the obstruction. These two types of obstruction, therefore, constitute also the absolute contra-indications to attempts at decompression by conservative means.

In determining whether a satisfactory decompression has been achieved by conservative means (suction applied to an inlying duodenal tube), frequent recourse to roentgen evidence is most important. It is the practice of this clinic to take roentgen scout films at least every 12 hours to follow the decompression. Relief of pain, alone, is not enough. Failure to decompress the distended intestinal coils after a reasonable time with suction suggests that operative intervention (freeing the obstruction or enterostomy) is in order. Protracted attempts at conservative de-

compression, though not infrequently successful, are, in the main, hazardous and should be avoided. Most partial obstructions of a simple nature can be decompressed satisfactorily by the indwelling tube. High grade complete obstruction if not decompressed satisfactorily by suction within from 24 to 36 hours should be submitted to operation. Enterostomy, in the experience of the writer, is the safest operation in such instances (15).

The Miller-Abbott (1) tube has contributed materially to achieving quicker decompression when the pyloric sphincter has been negotiated. The difficulty is that in the instances in which the greatest distention is present, in these very cases in which entry of the balloon-tipped catheter into the duodenum is especially desired, just in these cases, it is most difficult to accomplish.

It is to be observed that during the seven-year interval (Table II) over which time suction has played an important rôle in the management of bowel obstruction at the University of Minnesota Hospital, a fairly large number of cases have been decompressed by suction alone (43.6 per cent). In the last year of that report, the Miller-Abbott tube was used frequently, as well as in an additional year's experience which has elapsed since the time of that report. With employment of the balloon-tipped tube we have been unable to extend the indication of non-operative treatment of mechanical obstruction or increase the frequency with which decompression can be achieved by conservative means. The quicker decompression achieved by its use, however, is very reassuring to the surgeon.

The Miller-Abbott tube has proved of value in another connection, namely, in the detection of occult lesions in the gut, such as neoplastic strictures which fail often to exhibit roentgenologic evidence of their presence. Not uncommonly, however, such strictures cause recurrent obstruction, which can be identified by the clinician during an obstructive phase by the presence of visible and palpable peristalsis—findings which suggest hypertrophy of the muscle of the gut wall.

The experience of the University Hospital in the treatment of obstruction is summarized briefly in Tables I and II.

## SUMMARY

A careful consideration of the roentgen findings in acute intestinal obstruction in the light of the clinical observations permits the clinician to determine with a high degree of accuracy:

(1) Whether obstruction is present.
(2) Where the obstruction is.
(3) Whether the obstruction is partial or complete.

The clinical findings, in the main, give reliable information whether the obstruction is simple or strangulating in character. Bearing in mind the systemic as well as the local effects of obstruction, and the worth of therapeutic procedures, it is apparent that a roentgenoclinical appraisal of the patient's status determines in large measure the proper choice of therapeutic procedure.

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# THE GROOVED DEFECT OF THE HUMERAL HEAD

## A FREQUENTLY UNRECOGNIZED COMPLICATION OF DISLOCATIONS OF THE SHOULDER JOINT

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INCENTIVE for this study was the discovery within a short period of time of two shoulders, each of which presented a large defect or groove in the posterolateral aspect of the head of the humerus (Figs. 3 and 4). The defect was variously interpreted by different consultants as due to infection, metastasis, and post-traumatic osteoporosis. A survey of the standard textbooks on roentgen diagnosis and on orthopedics was of no assistance in differential diagnosis. Accordingly, a detailed study of the literature was made and 119 cases of dislocated shoulder, examined roentgenographically at the San Francisco Hospital between the years 1930 and 1940, were reviewed. This led to a clarification of our original conceptions regarding the nature of this lesion, and identified it *not* as a late result of dislocation of the shoulder, but as a true fracture.

### REVIEW OF THE LITERATURE

Inasmuch as shoulder dislocations are the most frequent of all dislocations of the body, this subject has been of medical interest since ancient times. Hippocrates described the symptoms of dislocation of the shoulder and a method of reducing the luxation. Following Hippocrates, little was added to this subject until late in the nineteenth century when progress began to be made in the pathologico-anatomic changes occurring in shoulder dislocations.

In 1861, Flower (8) reported upon 41 shoulder specimens which he had studied after collecting them from all of the pathologic museums of London. He described cases which showed rupture of the tendons inserted upon the greater tuberosity, fracture of the tuberosity, or the presence of a groove excavated on the articular head posterior to the greater tuberosity. Between 1880 and 1903, there were many case reports (Kuster, 1882; Cramer, 1882; Popke, 1882; Loebker, 1887; Schuller, 1890; Staffell, 1895; Francke, 1898; Wendel, 1903), which described the pathologico-anatomic findings in humeral heads resected for the relief of chronic or habitual dislocation (9). In all these cases there was such a similarity in the change found by the various operators that the groove or excavation became known as the "typical defect." A composite description of these resected specimens may be summed up as follows: The defect is located posterior and medial to the greater tuberosity on the posterolateral aspect of the articulating surface of the humeral head. The groove is navicular or wedge-shaped and its average measurements are 2.5 cm. in length (cephalocaudad), 1.5 cm. in width, and 0.75 cm. in depth. The defect is demarcated from the surrounding normal bone by sharp or vertically projecting walls, which in the larger defects stand at a right-angle to each other. The spongiosa bordering the defect is thicker than elsewhere and is covered with a glossy, smooth connective tissue layer. No fragment avulsed from the humerus is to be seen (Fig. 1).

Since more conservative methods have displaced resection as a method of treatment for habitual shoulder dislocations (4, 5, 10), the defect is frequently not discovered as a result of operation, especially if the anterior approach and extracapsular methods are used. However, x-ray studies, if properly made, will reveal the defect.

In 1906, Perthes (13) described the roentgenologic appearance in two cases and in 1914 Schultze (15) published the results of the first carefully studied series of cases. However, it was not until 1925 that Pilz

(14) first demonstrated the fact that the success or failure of the x-ray examination is dependent upon the technic used.

## ETIOLOGY

The mechanism of anterior dislocations of the shoulder have been well described by numerous authors (1, 9, 10, 16). In brief: With the arm abducted and internally rotated, trauma is transmitted along the longitudinal axis of the humerus, forcing the head inferiorly. The head is forced out of the glenoid fossa by external rotation and against the anterior rim of the glenoid. In many instances the force of impaction is sufficient to fracture off all or a portion of the greater tuberosity, or, more rarely, the neck of the humerus is fractured. In other cases, in which the posterolateral aspect of the humeral head and its weakest portion impinges on the glenoid rim, a compression fracture of the spongiosa of the former region occurs. This compressed area is usually of sufficient size to permit detection on the roentgenograms as a so-called "typical defect"; less often it results in but a slight flattening of the contour of the humeral head or in minute infractions which later lead to cystic changes.

There have been many theories offered in the past to account for the defects noted in the resected specimens and roentgenograms. Some of these are as follows: (1) congenital anomaly; (2) osteochondritis dissecans; (3) avulsion fracture with absorption of fragment; (4) aseptic or pressure necrosis following damage to blood vessels of the head; (5) post-traumatic inflammation.

A knowledge of the mechanism of shoulder dislocations and of the pathologico-anatomic changes present in this lesion (3, 6, 10, 12, 16) makes the above theories untenable. Furthermore, there is sufficient evidence, especially roentgenographic, to prove that such defects do occur immediately following a single injury to a shoulder previously proven to be normal. Malgaigne (11), prior to 1880, conjectured that such might be the case. Eve (7), in 1880, reported the first proven case. His patient died twelve hours after a train accident in which one shoulder sustained an injury. On examination of the humeral

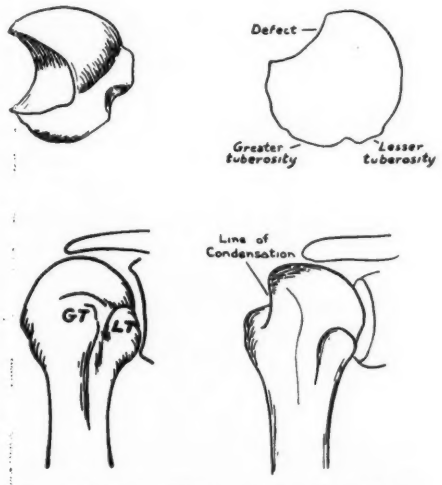


Fig. 1 (*upper*). Diagrams of profile and cross-section views of grooved humeral heads resected for habitual dislocation (*from Kuster and Cramer*).
(*Lower left*) Diagram of an x-ray of a normal humerus in internal rotation.
(*Lower right*) Diagram of an x-ray of a humerus in internal rotation, showing defect.

head a deep groove of recent origin was found on the posterolateral aspect of the head of the humerus. Hermodsson (9) states that his studies have shown that in many instances the defect occurred at the time of the first dislocation and did not change appreciably later, in spite of additional luxations. He reports 18 cases in which the defect was demonstrated before reduction was attempted. One of his cases was roentgenographed one hour following a fall from a motorcycle, and though the patient had replaced the dislocation a large defect was found. Roentgenograms of another individual taken during March, 1930, following a fall showed no damage, but on re-examination of the same shoulder following a dislocation in May, 1930, a defect was noted. We have a very similar case in our series (Fig. 4). Films taken of the left shoulder for comparison at the time of a disorder of the right were negative. Examination two months later, immediately after a subcoracoid dislocation of the

left humerus, showed a definite defect. Therefore, after a review of the literature and a study of our own cases, we are convinced that the "typical defect," and probably also the cystic changes present in a few cases, are the result of *compression fractures* of the comparatively soft bone comprising the posterolateral portion of the head of the humerus.

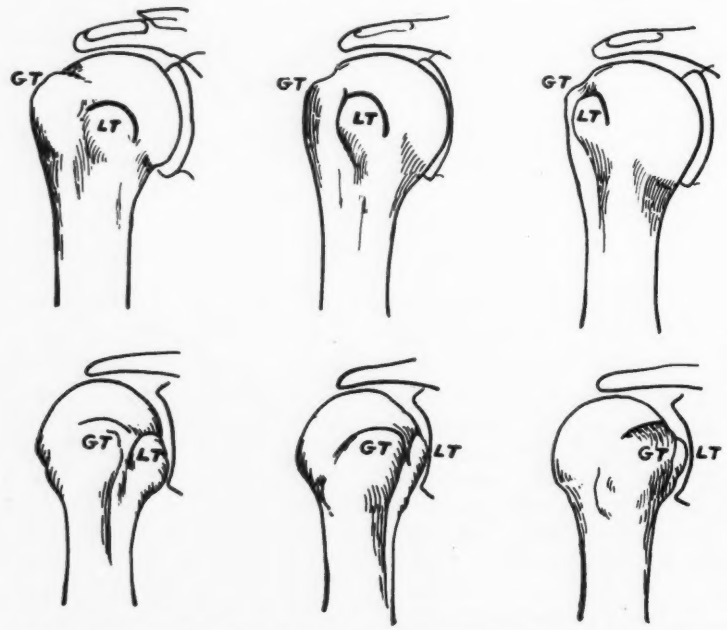


Fig. 2. Diagrams of x-rays of the humerus in increasing degrees of rotation to illustrate the fact that only in marked internal rotation is the posterolateral aspect of the humeral head seen in profile.
(*Upper*) External rotation of humerus: (*left*) slight rotation; (*center*) moderate; (*right*) marked.
(*Lower*) Internal rotation of humerus: (*left*) moderate rotation; (*center*) marked; (*right*) very marked.

### INCIDENCE

About 95 per cent of shoulder dislocations are anterior in position. The following classification of the varieties of anterior displacements is the one that we prefer: (*A*) Subglenoid; (*B*) Anterior or axillary; (*C*) Subcoracoid. The subcoracoid position of the head is the third or last stage in anterior displacements of the humerus, nevertheless it is the most frequently seen variety, outnumbering by more than three to one the subglenoid type.

Figures for the incidence of compression fractures producing the "typical defect" in the head of the humerus are rare, most reports being of but one or two cases. A few authors have reported their results from roentgenologic investigations of a series of habitual dislocations of the shoulder.

TABLE I.—CASES OF HABITUAL DISLOCATION OF THE SHOULDER, STUDIED ROENTGENOGRAPHICALLY

| Investigator | No. Cases Studied | No. Defects Found | Percentage of Incidence |
|---|---|---|---|
| Schultze | 24 | 5 | 20 |
| Boicev | 31 | 11 | 35 |
| Pilz | 21 | 15 | 71 |
| Bazy | 7 | 7 | 100 |
| Hermodsson | 23 | 23 | 100 |

Pilz and Hermodsson have correctly shown that the percentage of defects found will be greatly influenced by the

thoroughness of the x-ray examination. Hermodsson found 24 out of 40 cases of recent or "fresh" dislocations in which defects could be demonstrated by his ordinary or routine shoulder examination, including views with the arm in internal rotation. Nine additional cases (of the 40) were shown to have defects, by the use of his specially devised tangential projection, thus changing the frequency of occurrence in this group from 60 to 82 per cent.

Small cyst-like areas in the posterolateral aspect of the humeral head have been described by a few investigators. It has been claimed by some that the changes are due to slight compression fractures sustained at the time of dislocation, or to nutritional changes following the luxation. The number of such cases reported is small and figures as to incidence have not been given.

Most authorities place the frequency of recurrent or habitual dislocations of the shoulder (that is, instances in which there is more than one dislocation of the same shoulder) at from 10 to 15 per cent.

### ROENTGENOGRAPHIC FINDINGS

Compression fractures of the humeral head, unless quite large, will frequently be overlooked unless the x-ray studies are made with the possibility of such in mind. A stereoscopic anteroposterior examination with the arm adducted and in external rotation is *not* adequate to demonstrate the

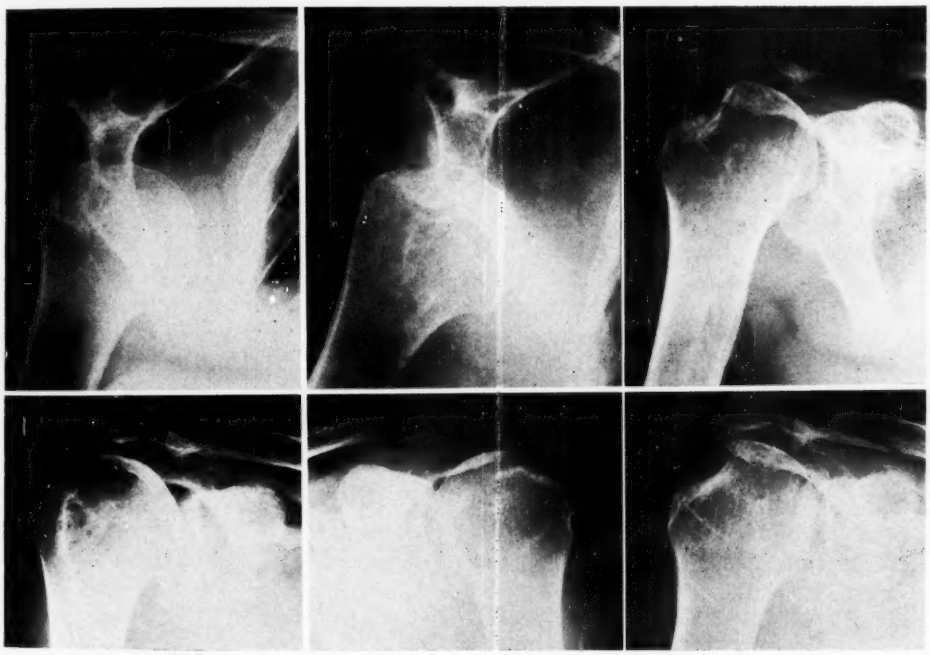

Fig. 3. Case 1 (*upper left*). Nov. 8, 1937. Subcoracoid dislocation of the right humerus; view in external rotation shows no groove.

(*Upper center*) June 27, 1938. X-ray made following re-dislocation, with the humerus rotated slightly externally reveals a slight flattening of the superior-lateral contour of the head.

(*Upper right*) Sept. 22, 1938. Following correction of the third dislocation, a large groove is visible when the humerus is in marked internal rotation.

(*Lower left*) Oct. 11, 1938. The right humerus in external rotation, routine projection, showing no visible defect.

(*Lower center*) Oct. 11, 1938. The left humerus in internal rotation for comparison with the right; no groove present.

(*Lower right*) Oct. 11, 1938. The right humerus in marked internal rotation; this projection clearly reveals the large defect which was "hidden" in the routine view. (This case presented through the courtesy of J. Minton Meherin, M.D.)

defect in many instances. An anteroposterior projection made with the arm in *marked* internal rotation is essential, and in a small percentage of cases the defect will be disclosed only by means of a tangential view of the posterolateral aspect of the humeral head. With marked internal rotation, the posterolateral aspect of the head is viewed in profile so that the length and depth of the compressed area may be evaluated (Fig. 2). The tangential view is necessary to measure the width; this view is obtained by placing the film on the top of the shoulder while the tube is lateral to and below the elbow, the arm being internally rotated.

The x-ray characteristics of such compression fractures are as follows:

1. The defect is located on the posterolateral portion of the humeral head; only when very large does it extend into the greater tuberosity.

2. In external rotation all that may be noted is a slightly increased rarefaction of the region medial to the lateral contour of the greater tuberosity, except in the case of extremely large defects, when a slight flattening of the contour may be noted. Both of these changes are easily overlooked, especially if a view of the opposite shoulder is not available for comparison.

3. With the arm in internal rotation there is:

(*A*) Flattening of the contour of the articular surface or, in larger defects, an indentation, excavation, or groove on a level with the greater tuberosity, and

(*B*) A sharp, dense line running downward from the top of the humeral head, parallel to the axis of the shaft and somewhat lateral to the mid-line. This "line of condensation" is a special sign and is the result of the compression or compaction into a narrow medial border of the spongy bone previously occupying the space of the defect (Fig. 1). Pilz believes that one may judge the size of the defect present by a measurement of this line.

(*C*) The floor of the defect (best seen in the tangential view) also shows a dense compacted border.

4. An avulsed fragment from the humerus is practically never present. There may be a small chip from the inferior portion of the glenoid rim of the scapula.

The size of the compressed areas varies considerably; however, from a study of our material, we believe that there is a definite correlation between:

(*A*) The size of the head of the humerus and the size of the defect;

(*B*) The size of the head of the humerus and the length of the line of condensation;

(*C*) The size of the defect and the length of the line of condensation (Table II).

The average case in which a typical defect is present shows the length of the line of condensation to approximate one-half the diameter of the widest portion of the head. The size of the defect may become larger following repeated dislocations; in a few cases the size has diminished as a result of partial filling in of the defect with new bone (Fig. 3).

Cystic changes are usually easily discernible because of their macroscopic size (diameters of from 2 to 12 mm.) and well delimited borders of increased density. They are localized in the posterolateral

TABLE II.—MEASUREMENTS OF OUR MATERIAL USED IN ESTABLISHING CORRELATION BETWEEN SIZE OF HEAD, SIZE OF DEFECT, AND LENGTH OF LINE OF CONDENSATION

| Size of Defect | | Length of Line of Condensation | | | Diameter Widest Part of Head | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 cm. | 3 cm. | 4 cm. | 4 cm. | 5 cm. | 6 cm. | 7 cm. |
| Small | 5 cases | 5 cases | 1 case | 0 case | 2 cases | 2 cases | 1 case | 1 case |
| Medium | 16 cases | 5 cases | 7 cases | 2 cases | 0 case | 5 cases | 6 cases | 2 cases |
| Large | 4 cases | 0 case | 0 cases | 5 cases | 0 case | 1 case | 2 cases | 3 cases |

portion of the humeral head and occur just beneath the articular surface. They sometimes appear to communicate with the joint space.

### DIFFERENTIAL DIAGNOSIS

Occasionally a grooved defect in the humeral head may be confused with a fracture of the greater tuberosity. This will seldom, if ever, occur if a thorough x-ray examination is made, because the location of the two lesions is different and a fragment can usually be made out in cases of fracture of the tuberosity. If the greater tuberosity fragment unites with its base in a somewhat displaced position or is partially absorbed before union takes place, the contour of the greater tuberosity will show some irregularity of outline (Fig. 7, *upper*). The tuberosity fragment may not unite, in which instance it is absorbed; the resultant appearance is that of a very flattened tuberosity or as if the tuberosity had been sheared off (Fig. 7, *lower*).

In posterior dislocation of the humerus an area of absorption has been noted on the anterior aspect of the articular surface of the head (17). In this case the location will serve as a differential guide.

An apparent groove is sometimes noted in certain projections of the shoulder in humerus varus. However, a thorough study including projections in other planes will reveal no true defect.

In caries sicca and in Charcot's osteoarthropathy of the shoulder there may be

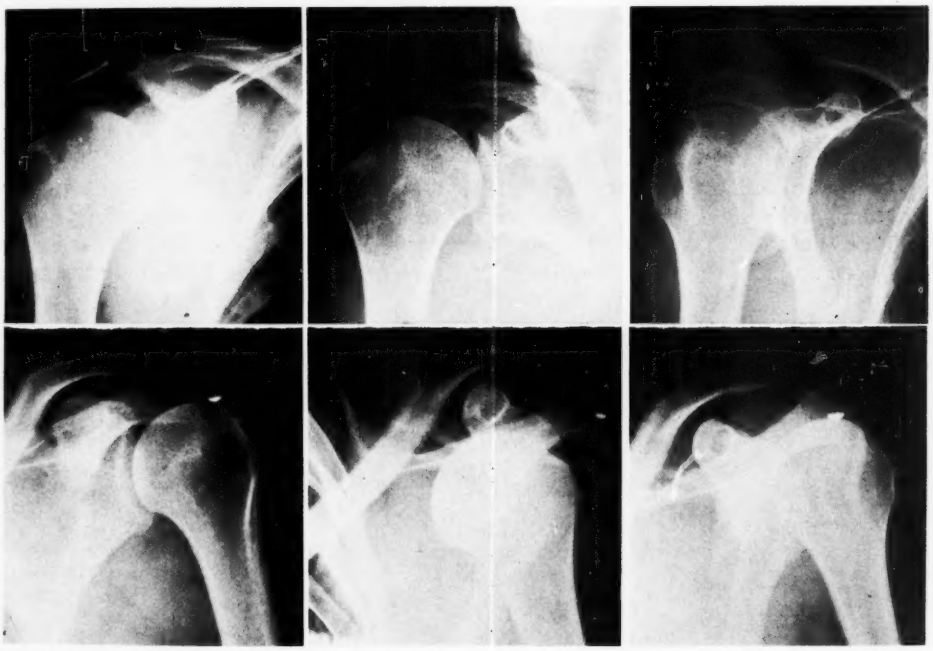

Fig. 4. Case 2 (*upper left*). Nov. 28, 1938. The right humerus in external rotation; no groove visible.
(*Upper center*) Sept. 21, 1938. The right humerus in external rotation immediately after correction of a subcoracoid dislocation; only an experienced observer would detect the suggestion of a compression fracture.
(*Upper right*) Sept. 22, 1938. The same humerus taken a day later but in marked internal rotation with the large defect and line of condensation very obvious.
(*Lower left*) Nov. 28, 1938. The left humerus in internal rotation; negative—taken only for comparison with right.
(*Lower center*) May 11, 1939. The left humerus following first dislocation; no defect visible in this projection.
(*Lower right*) May 11, 1939. The same humerus following reduction and with the humerus in marked internal rotation; a deep groove and dense line of condensation are made out.

changes at certain stages which will simulate the changes following a compression fracture. A complete clinical and laboratory examination will make an accurate differentiation possible.

Arthritis deformans, atrophy (senile or following rupture of the external rotator tendons), osteomalacia, and rachitis might, at times, be confused with small compression fractures or with the cystic changes following dislocations. The differential diagnosis depends upon the history of preceding trauma, bilateral nature of the systemic disorders, and the sharply localized site of the compression fractures.

## REVIEW OF OUR CASES

We have reviewed 119 shoulder dislocations seen at the San Francisco Hospital between 1930 and the Summer of 1939. It has been only during the last six months of this interval that the x-ray examinations have been adequate to rule out positively the possibility of a small defect or fracture. While we attempted to have all of the 119 individuals return for a thorough follow-up x-ray examination, we were able to obtain such studies on only a relatively small percentage. These facts undoubtedly account for the low incidence of grooved defects of the humeral heads found in our series of cases.

## CASE REPORTS

Case 1. G. S., 61-year-old male, with no history of previous trauma, fell in a ditch on Nov. 8, 1937; a right subcoracoid dislocation was corrected. He redislocated the same shoulder while turning in bed on June 27, 1938, and again on Sept. 22, 1938. X-ray examinations of June and September revealed a large (4 cm. in length) defect in the posterolateral aspect of the right humerus (seen only in internal rotation). The left shoulder was negative at all examinations.

The serial studies show an increasing sclerosis of the walls of the groove, also a slight filling in of the defect between September and October, 1938. It is probable that such large grooves as were exhibited in this case explain some of the failures of capsulorrhaphy (18). (See Figure 3.)

Case 2. J. S., 37-year-old male, chronic alcoholic; history unreliable. Entered the hospital on Nov. 28, 1938, complaining of pain and limited abduction of right shoulder. X-rays made at this time were negative for dislocation, but showed a moder-

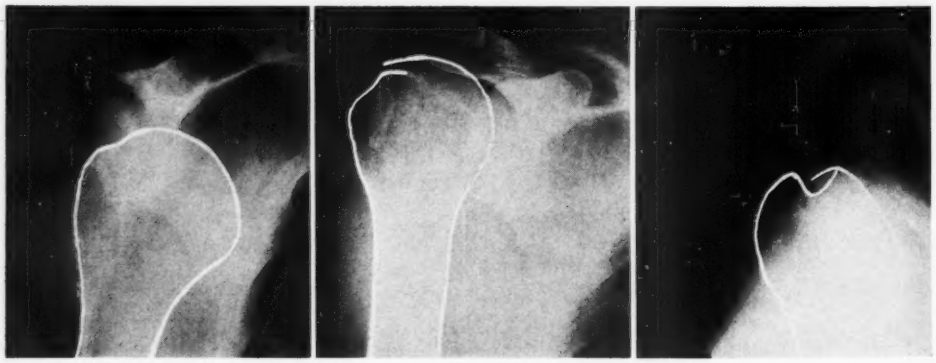

Fig. 5. Case 3 (*left*). Feb. 1, 1938. The right humerus following original injury; subcoracoid dislocation but defect cannot be seen.

(*Center*) Feb. 2, 1938. The following characteristics of the typical defect are present: deformed contour and washed-out appearance of the posterolateral aspect of the humeral head, a fairly dense line of condensation, and no visible fragment.

(*Right*) Feb. 2, 1938. Tangential view of the posterolateral portion of the humeral head showing the groove as the result of the compression fracture. *Note.*—The bicipital groove has much the same appearance but is situated anteriorly and usually is smaller.

ate sized defect. The same shoulder was dislocated in an automobile accident on Feb. 21, 1939. Films made the following day in internal rotation revealed a large groove with sharp line of condensation. The right shoulder was again dislocated in March and in May, 1939. All x-ray examinations revealed the large defect but an operation on this shoulder in May failed to disclose any defect, presumably due to the anterior approach and small size of the operative field (18). (See Figure 4, *upper.*)

The original x-rays of the left shoulder taken for comparison on Nov. 28, 1938, were negative. Examination following a subcoracoid dislocation of the left humerus on May 11, 1939, revealed a deep groove in the posterolateral portion of the humeral head and medially a well defined line of condensation. This defect was undoubtedly due to the recent injury of May 11. (See Figure 4, *lower.*)

Case 3. C. N., 54-year-old male, fell, injuring his right shoulder; no history of previous injury to this arm. The fall occurred on Jan. 15, 1938, but it was not until Feb. 1, 1938, that he entered the hospital for medical attention, at which time x-rays revealed a moderate sized groove in the humeral head; the line of condensation can be fairly well made out on the original films. The tangential view clearly shows the lesion. It is our belief that the compression fracture was in all likelihood sustained at the time of the fall in January (Fig. 5).

Case 4. I. S., 50-year-old male, struck his left shoulder against a table while wrestling. He went to a doctor two weeks later, at which time a dislocation was corrected (June 20, 1932). He re-dislocated this shoulder on Jan. 14, 1933, on Aug. 7, 1933, and again in January, 1934. The serial x-ray studies show a gradual increase in the cystic changes located in the posterolateral portion of the humeral head following each subsequent dislocation (Fig. 6, *upper*).

Case 5. G. H., 52-year-old male, sustained a subglenoid dislocation in April, 1938. X-rays made immediately following the reduction exhibited a little flattening of the contour of the posterolateral aspect of the articular surface of the humeral head, probably due to a slight compression fracture. Because of slight limitation of function, he had further x-rays made in July and in October; these showed the development of cystic changes in the posterolateral portion of the head of the humerus (Fig. 6, *left lower*).

Case 6. B. R., 68-year-old male, dislocated (subcoracoid) his left shoulder in February, 1936. It was immediately reduced. A check-up examination early in March showed rather marked cystic changes in the posterolateral portion of the humeral head, especially for such a short interval of time between the injury and the appearance of these changes. This finding favors a compression fracture origin rather than one due to nutritional changes (Fig. 6, *right lower*).

Case 7. T. L., 44-year-old male, fell against a garbage can on Feb. 6, 1937. A subcoracoid dislocation with a comminuted fracture of the greater tuberosity was treated (Fig. 7, *upper left*). Two years later an examination revealed that the fracture had united, but a portion of

TABLE III.—INCIDENCE OF THE COMPLICATIONS OF ANTERIOR DISLOCATIONS OF THE SHOULDER FROM A STUDY OF THE X-RAYS OF 119 CASES SEEN AT THE SAN FRANCISCO HOSPITAL, 1930–1939

| | | |
|---|---|---|
| Dislocations which were recurrent | 15 | 12% |
| Dislocations which were uncomplicated | 27 | 24% |
| Dislocations complicated by: | | |
| (1) Compression fracture | 33 | 27% |
| (*a*) Typical defect | 25 | 21% |
| (*b*) Cystic changes | 8 | 6% |
| (2) Fracture greater tuberosity | 44 | 37% |
| (*a*) and fracture humeral neck | 2 | 2% |
| (*b*) and fracture glenoid rim | 8 | 7% |
| (3) Fracture glenoid rim | 18 | 10% |

Recurrent Dislocations

| | |
|---|---|
| 11 showed compression fractures | 74% |
| 2 showed fracture greater tuberosity | 13% |
| 2 showed no complication | 13% |

Age Incidence

| Ages | 1–15 | 16–30 | 31–45 | 46–60 | 61–75 | 76 and over |
|---|---|---|---|---|---|---|
| Cases | 3 | 10 | 18 | 56 | 27 | 5 |

Sex Incidence

| Males | Females |
|---|---|
| 64 | 55 |

the greater tuberosity had been absorbed and the contour of the tuberosity was quite irregular; also, there was a deepened sulcus at the anatomic neck (Fig. 7, *upper right*). A comparison of the end-result in this case with the changes seen following a compression fracture of the posterolateral portion of the humeral head (as, for example, in Case 1) should enable one to state the nature of the original injury in each instance.

Case 8. J. J., 65-year-old male, ten days prior to his entry to the hospital in August, 1937, slipped in a bathtub, striking and dislocating his left humerus and fracturing the greater tuberosity. The dis-

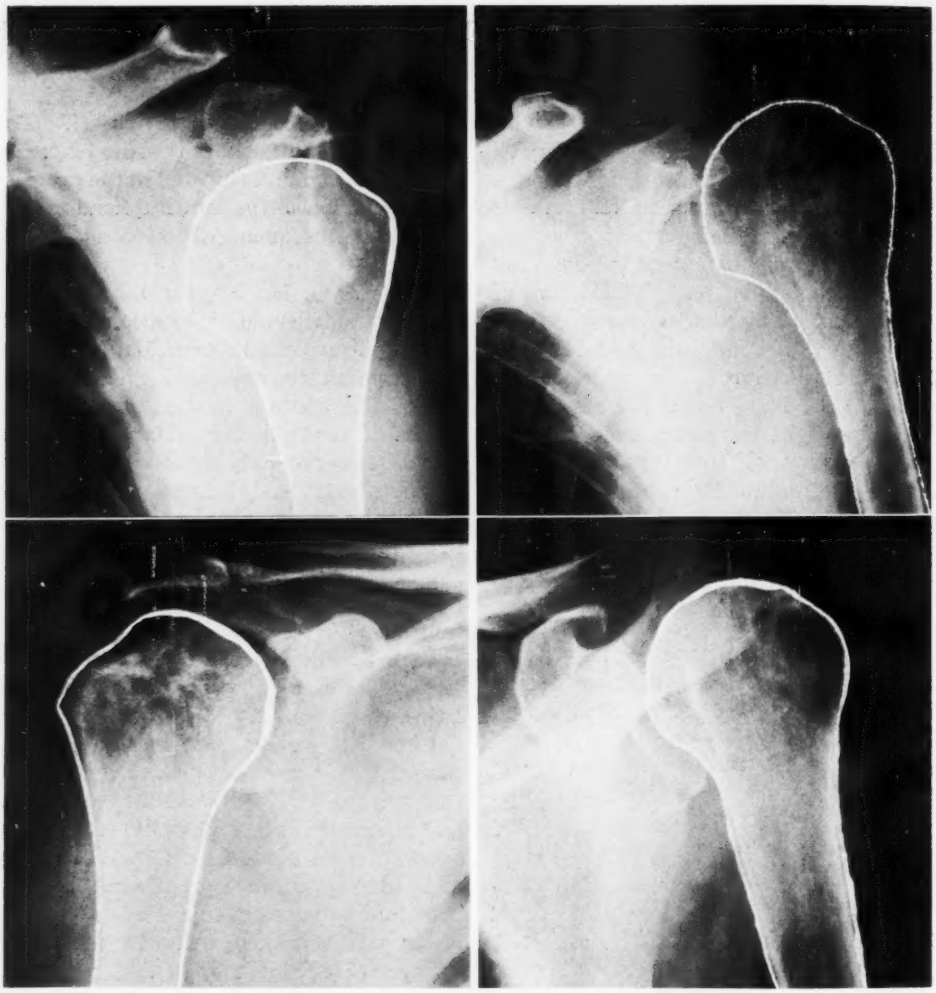

Fig. 6. Case 4 (*upper left*). June 15, 1932. The left humerus following first subcoracoid dislocation; no cystic changes are present.

(*Upper right*). Jan. 14, 1935. Re-examination following reduction of fourth dislocation of left shoulder; quite marked cystic changes are observable on the films.

Case 5 (*lower left*). Oct. 10, 1938. X-rays made six months after the first and only dislocation show both a shallow groove and rather marked cystic changes, neither of which was present at the examination in April.

Case 6 (*lower right*). March 2, 1936. Cystic changes present in the posterolateral portion of the humeral head best disclosed by projection made with the humerus in marked internal rotation.

location was reduced but marked disability followed because of lack of grip and loss of external rotation. X-ray examination made 18 months later shows that the fragment has been completely absorbed and the region of the base of the tuberosity has a sheared-off appearance (Fig. 7, *lower right*).

On superficial examination of the appearance of the end-result in this case, one might suspect that the original injury was a compression fracture of the humeral head, but a careful check of the x-ray characteristics found in the latter type of injury will permit a ready differentiation.

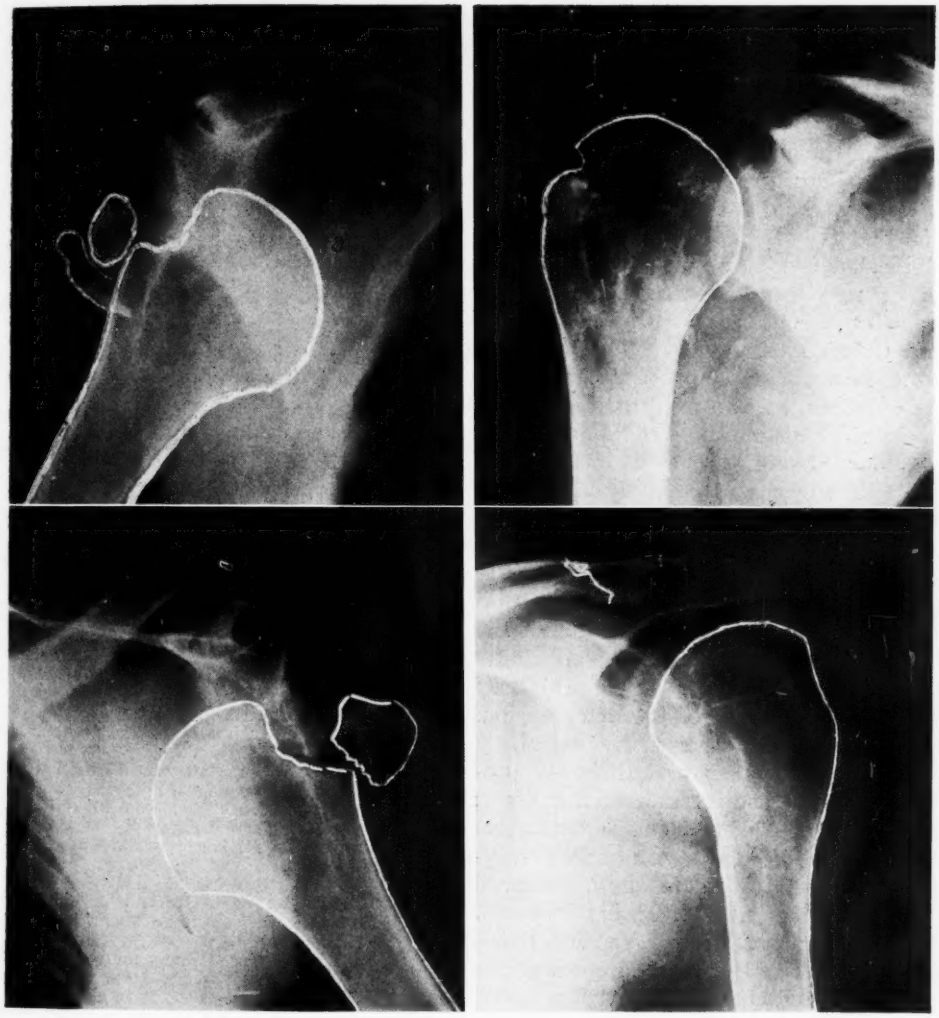

Fig. 7. Case 7 (*upper left*). Feb. 6, 1937. Subcoracoid dislocation and comminuted fracture of the greater tuberosity.

(*Upper right*) Feb. 8, 1939. Examination two years later reveals irregular outline of the greater tuberosity and deepened anatomical sulcus. Compare with Figure 3 for similarities and differences.

Case 8 (*lower left*). Aug. 14, 1937. Subcoracoid dislocation of the left humerus with fracture of the greater tuberosity.

(*Lower right*) Feb. 14, 1939. Bone fragment absorbed; base of tuberosity has a sheared-off appearance. Comparison with Figures 3 and 4 demonstrates the difference between the two not uncommon lesions.

SUMMARY AND CONCLUSIONS

1. More than two-thirds of the dislocations of the shoulder are complicated by a bony injury of the humerus or scapula detectable by roentgenographic means.

2. Fractures of the greater tuberosity alone or in combination with fractures of one or more parts of the scapula, most frequently the glenoid rim, comprise the most common group of bony injuries complicating shoulder dislocations in this series.

3. Compression fractures as a result of impingement of the weakest portion of the humeral head, that is, the posterolateral aspect of the articular surface, against the anterior rim of the glenoid fossa are found so frequently in cases of habitual dislocation that they have been described as the "typical defect." If large, such grooved defects may lead to unsatisfactory results following the usual operations for recurrent dislocations.

4. There is ample proof that many of these defects are sustained at the time of the original dislocation and they may be an etiologic factor in recurrent dislocations.

5. Roentgenographic study is the best method of obtaining a true conception of the presence, location, size, and form of the defect.

6. A minimal x-ray examination comprises an anteroposterior projection of the shoulder with the arm in adduction and external rotation and a similar projection with the arm in marked internal rotation. Tangential views often prove useful.

7. The x-ray characteristics of posterior humeral compression fractures are: a wedge-shaped defect of the posterolateral aspect of the head of the humerus, varying from 5 mm. to 3 cm. in length, 3 mm. to 2 cm. in width, and 10 to 22 mm. in depth. A special sign is the sharp, vertical, dense medial border of the groove known as the "line of condensation," the length of which is correlated with the size of the defect.

8. Small cystic changes in the subchondral portion of the posterolateral area of the humeral head are present in a few cases after shoulder dislocations. These are presumably due to small compression fractures but may possibly be due to nutritional changes following damage to minute blood vessels supplying these areas.

9. A more widespread knowledge regarding the possibility of the existence of these lesions should lead to better results in the treatment of shoulder dislocations and disabilities. The determination of a compression fracture defect also is of obvious medico-legal importance.

Our thanks are extended to Dr. Russell Klein who made the clinical examination on all the patients presented and to Dr. Martha Mottram for making the diagrams.

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# ROENTGENOGRAPHIC FINDINGS IN THE NEUROCUTANEOUS SYNDROMES[1]

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THE subject of neurocutaneous disease (congenital ectodermoses) has received but scant attention in the roentgen literature. This may be due, in part, to its relatively great rarity on the one hand, and, on the other, to the unfamiliarity of roentgenologists with the condition.

In considering the subject of neurocutaneous disease, four outstanding entities attract attention. These are:

1. Bourneville's Tuberous Sclerosis (Epiloia)
2. von Recklinghausen's Neurofibromatosis
3. Angiomatosis Cerebri, associated with Trigeminal nevus (Sturge-Weber's Disease, Parkes-Weber-Dimitri's Disease)
4. von Hippel-Lindau's Disease.

## TUBEROUS SCLEROSIS

Tuberous sclerosis is a rare condition, which, in its full-blown form (epiloia), frequently presents the following symptomatology:

(1) Epileptic seizures (grand mal, petit mal, or Jacksonian type)
(2) Mental deficiency
(3) Acneform butterfly facial rash (adenoma sebaceum—morbus Pringle)
(4) Periungual fibromas
(5) Congenital tumors of the eye (phacoma of van der Hoeve), and of many other organs, including rhabdomyomas of the heart and hypernephromas of the kidney.

In addition, many other congenital defects may be apparent, such as harelip, cleft palate (5), hypoplasia of the kidney and ureter, pulmonary artery stenosis, simian hands, hypertrophy of the external ears (50), high-arched palate, spina bifida, microcephaly and accessory digits (111), syndactyly, hemihypertrophy, epicanthus (23), transposition of the great vessels, and intestinal polyposis.

The entity was first described by Bourneville, in 1880 (6, 7, 8). His patient was a three-year-old child who had suffered from localized convulsive seizures for the first fourteen months following birth. There was present what we now know to be a typical adenoma sebaceum on the skin of the face, although at that time the importance of the skin manifestations was overlooked. The description, however, was accurate: "acné rosacée et pustuleuse de la face; de plus éruption vésiculo-papuleuse du nez, des joues, du front; nombreux petits molluscums à la nuque et sur les parties du cou." At necropsy, the reason for the right-sided convulsions was discovered. The ascending frontal and parietal convolutions on the left were obliterated by plaques of sclerotic tissue. Bilateral kidney tumors were found. The author came to the conclusion that he was probably dealing with a chronic inflammatory process, an hypothesis which is no longer tenable.

*Pathology.*—Since the work of Bourneville, a majority of the reports dealing with tuberous sclerosis has described the pathology of the condition. Among the authors who have made important contributions are: Sailer (90), Campbell (17), Sherlock (95), Freeman (41), Lind (71), Bielschowsky (5), Critchley and Earl (23), Brushfield and Wyatt (10), Babonneix (3), Yakovlev and Guthrie (111), Farber (38), Walsh, Koch, and Brunsting (106), Ferraro and Doolittle (39), and Globus (48).

Since it would be untimely here to dis-

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cuss the morbid anatomy of this condition in detail, only a brief summary will be given. Tuberous sclerosis gets its name from the potato-like, sclerotic patches which are scattered indiscriminately over the surface of the brain. On palpation, one can readily distinguish the soft consistency of the normal cortex from that of the heterotopic plaques, which have a rather rubbery composition and have been likened, by Lind (71), to nasal cartilage or hard paraffin. The pathology, however, is not limited to the outer layers of the cortex, and on opening the lateral ventricles one usually finds numerous subependymal proliferations, closely associated with the choroid plexuses (10). These tumors show a remarkable resemblance to "hypertrophic keloid formation" or "candle gutterings" (71). In rare instances, as described by Globus (48), atypical spongioblastomas may be found in the brain, but the morbid processes tend, in general, to spare the cerebellum (23).

The density of the plaques is accounted for by the close feltwork of neuroglial proliferation, which is seen in the microscopic section. Scattered among and between these areas can be seen large giant cells (*Riesenzellen, Grossenzellen*), which apparently take their origin from either the primitive spongioblasts or neuroblasts, apolar cells of Held, 23. The glial types show a predilection for the intraventricular tumors and are characterized by an absence of both Nissl granules and intracellular fibrillary network. The above described changes cause a complete disorientation of the pyramidal cells, which are diminished in number, and create widespread changes in the myelo-architecture.

Bielschowsky (5) was of the opinion that the pathologic process was a combination of neoformation and malformation, but more recent authors, such as Ferraro and Doolittle (39), feel that histologic studies lend little support to the latter theory. They rather favor the concept that the changes represent a purely neoplastic process. It should be borne in mind that the pathology is not alone limited to the brain but that, as described by Dickson (33), "the condition is characterized by congenital dislocation tumors in all or any of the following sites: brain, kidney, heart, skin, more rarely the pancreas, duodenum, thyroid, and breast." The kidney tumors are often indistinguishable from Wilms' tumors, or typical hypernephromas. Critchley and Earl (23) state that the renal tumors are rarely diagnosed during life, are usually multiple and bilateral, and of the embryonal mixed type, angiosarcomas, liposarcomas, myosarcomas, etc.

According to many authors, the convulsive seizures differ in no way from those seen in idiopathic epilepsy. However, Sherlock (95), and more recently Berkwitz and Rigler (4), contend that they can be differentiated by the long periods of remission. It is not uncommon to find sudden cessation of the attacks, which in no way seems to influence the steady progression of the mental deterioration (55). For instance, Critchley and Earl (23) record a remission of seven years' duration. Lind (71) states that 50 per cent of cases have fits in the first year, and that there appears to be little or no relation between the severity of the convulsions and the extent of the adenoma sebaceum, which is the most frequently associated skin disorder.

The usual history is that of a mild, early seizure which, as time advances, becomes more and more severe and may ultimately be directly responsible for death in *status epilepticus*. In agreement with what has gone before, Freeman (41) states: "The attacks are quite evenly spaced and are not so frequent as genuine epileptic attacks, nor so paroxysmal as those of the atrophic sclerosis." Critchley and Earl (23) point out that when a focal area of gliomatous hyperplasia becomes advanced enough, Jacksonian seizures may occur. In many cases no convulsive phenomena are present but in their stead epileptic equivalents, such as screaming fits and fainting attacks (37), occur. One case of sudden death has been reported (102). This was atypical in that there was no history of mental

deterioration, convulsions, or any evidence of cutaneous manifestations. A score of small tumors, showing the typical giant cells of tuberous sclerosis, were found at autopsy.

Globus and Selinsky (47) have called attention to the great difficulty in antemortem diagnosis when this disease exists in abortive forms, as it so frequently does in children. The following latent forms have been classified by Critchley and Earl (23) as:

(1) Adenoma sebaceum, alone
(2) Adenoma sebaceum, with epilepsy but without mental defect
(3) Adenoma sebaceum, with symptoms pointing to intracranial neoplasm
(4) Visceral tumor alone, with familial history of tuberous sclerosis.

It is in these types that we feel cerebral pneumography is particularly indicated, because here diagnosis so frequently needs clarification.

*Adenoma Sebaceum.*—The dermatologic manifestations of tuberous sclerosis are of paramount importance in arriving at a diagnosis. Lind (71) and Ferraro and Doolittle (39), among numerous other writers (10, 23, 31, 82, 83, 93, 105, 111), have stressed this aspect of the subject. The facial lesion may be described as an acneform eruption, usually of a butterfly or bat-like distribution. It involves first the nasolabial and geniolabial folds, spreading upward over the crest of the nose to the eyelids and forehead and outward toward the outer canthi. Ordinarily it spares the lips, giving rise to the appearance of circumoral pallor. In general, the rash may be stated to have a trigeminal distribution.

Pringle (88) was among the first to describe the condition in detail, whence the name, "morbus Pringle" or "Pringle's nevus." The description of the eruption in Gertrude T., his twenty-five-year-old patient, is classical: "The eruption, which the patient says is painful in cold weather, consists of indolent, firm, whitish or yellowish sago-grain-like solid papules or little tumors embedded in the skin at different depths, or projecting from it, and varying in size from that of a pin point to a small pea." Intimately intermingled with these lesions, the author found numerous telangiectatic elements. Pringle commented upon the fact that the patients with these changes were "intellectually below par" and of a "mobile temper," and further stated that other nevoid cutaneous manifestations might be encountered. Although Pringle felt that the pathology consisted primarily of a hyperplasia of the sebaceous glands, later authors, particularly Yakovlev and Guthrie (111) and DeJong (31), have emphasized the fact that this probably is not the case; but that the pathology involves primarily the vascular and fibrous tissues of the skin, as well as the peripheral glia or Schwann cells.

Therefore, the condition appears to be closely related to von Recklinghausen's neurofibromatosis. van der Hoeve (105) also takes this stand and states that adenoma sebaceum is actually built of nevi in which the glands of the skin have proliferated.

Olson (83), Greig (52), and Critchley and Earl (23) distinguish three forms of this condition:

(1) The Balzer type—pale lesions without telangiectasis, histologically showing evidence of involvement of the hair follicles
(2) Pringle's Nevus—the pink or true telangiectatic type
(3) The Hallopeau-Laredde type—with the fibroma element predominating and the nodules of excessive hardness.

Special caution should be exercised not to confuse the above mentioned lesions with a dermatitis medicamentosa (23).

Adenoma sebaceum is only part of a widespread disturbance (ecto-mesodermal dyscrasia). Neurofibromas may be found on any portion of the integument. These may be superficial and pedunculated, as

are the typical fibroma mollusca, or be situated subcutaneously. Other stigmas of von Recklinghausen may be evident, including areas of vitiligo (anemic nevi of Voerner), which are likely to show a predilection for the lumbosacral region, and pigmentary disorders such as "café au lait spots."

Subungual and periungual fibromas deserve special mention here as they may constitute the chief complaint of the patient. One of our patients (Case 1) had just such a symptom, with treatment first directed to a periungual wart, by a chiropodist. Skeer (96) also has called attention to the importance of this sign. He feels that subungual warts are found most often at puberty, more often involve the toenails than the fingernails, and are more prevalent in females.

*Congenital Tumors of the Eye.*—Congenital tumors of the retina in tuberous sclerosis were first described by van der Hoeve, in 1920 (105). Subsequently, similar findings were noted by him in von Hippel-Lindau's disease and in von Recklinghausen's neurofibromatosis. Arising from the nerve fiber layer, these tumors appear as small white or gray flat spots, which may be located at, or some distance from, the papilla. According to Critchley and Earl (23), their diameter, as a general rule, never exceeds one-half the diameter of the papilla. In rare instances (Gottlieb and Lavine, 50), the tumor is surrounded by blood vessels, although more often vascular relationships are lacking. The tumor may project two to three diopters above the retina. Papilledema is absent unless there is an associated spongioblastoma of the brain. Occasionally the surface of the tumors has a rather granular appearance, and for this reason they have been likened to mulberries. van der Hoeve has termed these lesions "phacomas," from the Greek *phakos* or "mother spot." He differentiates two types, depending on the histologic picture, as follows:

(1) Neurofibrillophacomas, composed of neural fibers

(2) Neurocytophacomas, composed of neurocytes.

van der Hoeve has described the following experience in connection with the cysts which are frequently seen in these tumors. Ophthalmoscopically, he watched the rupture of such a cyst, which discharged its contents into the vitreous and, within a period of five days, refilled. At the same time pieces of tissue became detached from the tumor and he was able to follow their implantation on other portions of the retina, a "kind of internal metastasis."

The importance of the ophthalmoscopic findings has been stressed by Storcheim and Taube (103) who write: "The ophthalmoscopic findings in these cases are thus of great importance, for, essentially one is given the opportunity of seeing in the fundus positive proof of what he then knows to be present in the brain." van der Hoeve is of the opinion that the phacomas of Bourneville (tuberous sclerosis) and those of von Hippel and von Recklinghausen are closely associated although definitely different disease entities. It is his belief that the phacomas of von Recklinghausen's disease form an intermediate link between the angiomatosis retinæ of von Hippel and the retinal changes of tuberous sclerosis. Thus they are likely to show evidence of vascularity and cystic changes on the one hand, as in von Hippel's disease, with glial proliferation and neurocyte formation on the other, such as one encounters in tuberous sclerosis. Grinker (53) feels that the phacomas of Bourneville (tuberous sclerosis) are probably astroblastic neoplasms, although a sure classification, on the basis of tissue studies, is still wanting. In a recent publication (1939), Koch and Walsh (63) express the belief that these tumors are of a very low order of malignancy.

*Roentgen Findings in Tuberous Sclerosis.*—Dalsgaard-Nielsen (28) reported the roentgen findings in a boy, aged 14 years, who came from healthy peasant stock. There was no sign of neuropathic taint in

the family. Convulsive seizures had been present since the age of nine months, with adenoma sebaceum first noticed at the age of twelve years. The patient had previously had two operations for removal of recurring fibromas of the cervical region. Pigmentary and other cutaneous anomalies, similar to those seen in von Recklinghausen's disease, were also present. The roentgen examination of the head showed a small but otherwise normal sella. Numerous fleecy calcifications were noted throughout the calvarium. Some of these were interpreted as being purely hyperostotic formations of the internal lamina; others were apparently located within the brain itself. Most of the calcareous deposits were small and irregular, although "one of the calcifications lying in the center of the frontal lobe was distinguished from the rest by its size." This shadow was as large as an orange and showed an area of central rarefaction. The author states: "Roentgenologically demonstrable changes in the skull and brain in patients with tuberous sclerosis are excessively rare." Bone changes, mentioned by Gottlieb in reported cases, include those of Paget's disease, osteitis fibrosa, osteoporotic processes, tumors, and cysts. The latter author has reported a case with scattered densities and rarefactions of the calvarium in connection with thickening of the laminæ. A later examination showed a generalized osteomalacia and scattered periosteal thickenings with cyst-like cavities in the bones of the hands and feet.

Dalsgaard-Nielsen (28) gives credit to Marcus, of the Scandinavian literature, for the first case of tuberous sclerosis showing demonstrable calcifications within the brain. The author believes that most areas of calcification are present within the neoformations of the cerebrum, while the hyperostoses seen in the internal laminæ are independent processes, although, admittedly, they might result from the local irritant action of adjacent tumors. Unfortunately, no air study was done in the case reported above.

Regarding intracranial calcification, it may be said that those occurring in tuberous sclerosis must be considered along with, and differentiated from, other forms of non-physiologic cerebral calcifications, as those mentioned by Camp (13). These include the following entities which give rise to calcareous deposits:

(1) Tumors, hematomas (rare)
(2) Tubercles (rare), aneurysms
(3) Old abscesses, old meningeal disease
(4) Encephalitis
(5) Symmetrical cerebral calcification in parathyroidism (73).

Kveim (65) has recently described similar changes in cases exhibiting adenoma sebaceum, retinal phacomas, and tuberous sclerosis. All three of his patients showed cystic changes in the small bones. These were apparently localized to the spongiosa. One of our cases (Case 2), in addition to a soft-tissue shadow overlying the nail suggesting a periungual wart, showed very early cystic changes in the cortex of the distal phalanx of the thumb. It is noteworthy that these "cystic" changes are similar to those seen in von Recklinghausen's disease. Inasmuch as Hodges, Phemister, and Brunschwig (57) state that the pits in neurofibromatosis of bone are filled with connective tissue elements, it is not unlikely that on biopsy these porotic areas likewise will show evidence of fibro-connective tissue.

In the American literature, Gottlieb and Lavine (50) have reported analogous roentgen findings in a white woman, aged 23 years, who gave a history of retarded development and convulsions which ceased abruptly at the age of seven. The physical examination showed a typical adenoma sebaceum and numerous other lesions of the integument, including a typical shagreen patch. The funduscopic examination revealed bilateral retinal tumors. Certain stigmas of degeneration were also present; the patient's ears were excessively large, and the hands were simian in type. Roentgenograms of the cranium revealed a peculiar mottling, with areas of increased and

decreased density. Both the external and internal tables of the skull appeared thicker than normal. The roentgen examination of the hands and feet showed osteoporosis, periosteal thickening, and apparent cyst formation. The authors expressed the opinion that the bone changes could not be explained on the basis of a parathyroid dyscrasia, as the blood studies were entirely negative.....

The implication is obvious that there is a generalized disturbance with involvement of the mesenchyme. Indeed, Yakovlev (111), in discussing the above case, states:

"There are arguments in support of the view that, in the background of all these congenital anomalies of the skin there exists an embryonal disturbance of the differentiation of the ectodermal elements, the eventual prevalence of mesodermal elements (blood vessels and connective tissue) in their structure being a secondary process.....I wish to suggest that the unusual bony changes revealed in the present case are a part of the general picture of congenital abnormalities in the differentiation of tissues of ectodermal derivation. The cystic cavities might be explained on the basis of a *Schwannoma*, such as is seen in von Recklinghausen's disease, in view of the fact that the two conditions are so closely allied."

Drake (35)[2] has reported a "case of tuberous sclerosis with unusual clinical findings." The report concerned a 12-year-old Polish-American boy, who at the age of four, suffered from nocturnal seizures. Subsequently, visual hallucinations and hyperpyrexia developed. Physical examination, however, revealed neither retinal phacoma nor adenoma sebaceum. Encephalographic studies by Dr. Fay and Dr. Chamberlain showed discrete masses of calcification in the occipital region as well as bulging of the right thalamus into the right lateral ventricle. In addition, there was evidence of a microgyria. Although one would necessarily classify this case among the abortive forms, because of the absence of typical skin manifestations, nevertheless it was the opinion of Drake (35), in which we concur, that this clearly represented a case of tuberous sclerosis. One other feature of the history deserves comment. It is noteworthy that many reports of epiloia, such as those cases of Campbell (17) and Sherlock (95), mention the finding of transient hyperpyrexia. Undoubtedly the explanation of hyperthermia in many such instances lies in the fact that pedunculated subependymal gliomas in the ventricular system influence the temperature regulating centers of the hypothalamus by direct or indirect pressure.

DeJong (31) states that, prior to his publication, there were only three reports of pneumographic studies in tuberous sclerosis. That of Stewart and Bauer (101) showed hydrocephalus limited to the lateral ventricles without evidence of obstructive phenomena or intraventricular tumefactions. In the case of Berkwitz and Rigler (4), encephalography was performed on two occasions and showed an excellent picture of multiple tumor-like nodulations projecting into the lateral ventricles. An additional finding of importance was the absence of the septum pellucidum.[3] This patient, a girl two years of age, lacked the usual manifestations of adenoma sebaceum (morbus Pringle), presumably because, as emphasized by Caylor (19), sebaceous glands ordinarily do not appear before the age of four.

DeJong's report concerned a boy, aged eight years, who for four years had suffered from a facial eruption. On examination he showed a brilliant adenoma sebaceum of typical butterfly distribution. Papules, nodules, and areas of vitiligo involved the skin of the body elsewhere. A phacoma was present on the temporal side of the left disc. Stereoscopic roentgenograms revealed multiple intracranial deposits of calcium salts. Most of these were situated above the pituitary fossa in the region of the third ventricle. Cerebral pneumography disclosed an enlarged right lateral ventricle. Projecting into the lateral ventricle there was a soft-tissue shadow which extended backward from the foramina of Munro. In the posterior portions

[2] Reported again here, with roentgenograms.

[3] This was also found in our Case 3, reported below.

of the ventricles, numerous small soft-tissue tags were identified. These were interpreted as representing either subependymal gliomas or hyperplastic changes in the choroid plexuses. In view of the frequent finding of intraventricular tumors at autopsy, it is surprising that, heretofore, so few cases of cerebral air studies have been reported. The case of Drake, 35 (*vide supra*), fully emphasizes the diagnostic importance of pneumography in the abortive forms. Formerly the *formes frustes* were not differentiated antemortem. In this regard, the findings of Lind (71) are enlightening: "In the Kew series, the diagnosis was made in those who had adenoma sebaceum and the condition was undiagnosed in those who had no adenoma sebaceum." No doubt in the future more frequent recourse to encephalography will be had in suspicious cases, whether or not they show evidences of a nevoid facial eruption. By such a procedure it is not unlikely that many more cases will be brought to light and our knowledge of the subject considerably broadened, particularly through the study of the incomplete forms.

In passing, we should like to emphasize the importance of intravenous urographic examination in these patients, because, to our knowledge, no such study, showing a hypernephroma, has yet been described. It is of interest, however, that Fabing (37) has associated a kidney anomaly in one of his cases (reduplication of pelvis and ureter) with the possibility of a renal neoplasm. In the interesting article by Hyman (60) the fact that kidney tumors may be found in as many as 80 per cent of cases was pointed out. The writer states: "The percentage according to some authors is greater than this, for it was some time before the association was recognized, and, as a result, many cases were overlooked." In this instance the tumor was removed and showed no evidence of recurrence three years after operation. Crutchfield (24) has also reported a case of teratoma of the kidney associated with adenoma sebaceum, in which a roentgen examination showed displacement of one of the ureters toward the midline. Therefore, in these cases, it would appear advisable to include, among other studies, an examination of the genito-urinary tract, preferably by the intravenous method.

The reverse of the above proposition should also be borne in mind. Every case of hypernephroma, bilateral cystic, or horseshoe kidney, showing evidence of epileptic equivalents and mental defects warrants, we believe, a dermatologic consultation and a complete roentgen examination of the skull, including pneumo-encephalography.

The striking similarity between tuberous sclerosis and von Recklinghausen's neurofibromatosis has already been emphasized in part. Allusions have been made to the café au lait spots, the periungual fibromas, and other nodular cutaneous changes which are encountered. Indeed, it is the feeling of some that tuberous sclerosis is actually a central form of von Recklinghausen's disease, while von Recklinghausen's disease is a form of peripheral tuberous sclerosis (112). Though such a viewpoint may be hypothetical, as was recently pointed out by Aegerter and Smith (1), it is difficult to escape the fact that three of the syndromes (tuberous sclerosis, trigeminal nevus, and neurofibromatosis) have enough characteristics in common to force the conclusion that they are closely allied disease entities. This phase of the subject has been admirably reviewed by Yakovlev and Guthrie (111) and Schwarz and Abramson (93). The latter authors state:

> "Although all three syndromes show central manifestations which are characteristic of each disorder, they are by no means mutually exclusive. They present signs and symptoms which overlap to a considerable extent with an impressive range of variability, due to the interplay of factors permitting many combinations of developmental defects. Of special clinical interest is the occurrence of cutaneous anomalies which are indicative of associated maldevelopments in deeper seated, embryologically related structures, such as the central and peripheral nervous systems. Also of im-

portance is the frequent association of the three congenital disorders with mental defect and epilepsy."

In regard to the fourth syndrome of von Hippel-Lindau's disease, concerning which brief mention has already been made, it has been pointed out (93) that cutaneous changes are often lacking and that, therefore, it cannot be considered as one of the ectodermoses. We are, however, in agreement with the suggestion of Lévy (68) that the coincidence of angiomatosis retinæ and cutaneous syndromes is not impossible. Lévy cites the case of Oppenheim who reported the case of a child, aged ten years, who, on examination, showed both a hemifacial nevus and left-sided retinal tumors.

More recently Davison, Brock, and Dyke (30) have reported a case of central nervous system hemangioblastosis with unusual findings. Their patient not only showed numerous small telangiectases of the trunk, but, in addition, roentgenograms of the orbits showed demonstrable, bilateral, ring-like calcifications. A portion of this calcium deposit was found, at necropsy, to lie within the orbital hemangioblastomas. This probably represents the first reported occurrence of intra-orbital calcification in von Hippel-Lindau's disease and is of added interest because cutaneous manifestations were also present.

The recent thought on the similarity of these conditions is summarized by Worster-Drought, Dickson, and McMenemey (110) as follows:

"For some years past we have been of the opinion that there is a distinct relationship between a number of these syndromes characterized by multiple tumor formation, including not only Lindau's disease and tuberous sclerosis but also neurofibromatosis and its variants, as well as the conditions associated with it..... We also include as analogous conditions a number of other neoplastic syndromes, for example, myxochondro-adenoma of the base of the skull associated with cavernous angioma of the brain."

These authors feel that the hypothesis of embryonic induction is important in evaluating the varying exceptional processes which one encounters in cases of multiple tumor formation. This theory is of extreme interest because it accounts for the simultaneous co-existence of ectodermal and mesodermal malformations. According to this hypothesis, "evocator substances" are released by the nerve fibers which call forth, normally, a parallel arrangement of both Schwann cells and the orderly distribution of the adjacent mesodermal supporting tissues. Any derangement affecting the nerve elements (ectoderm), and, therefore, the evocator substance, may gravely influence the surrounding mesoblast, producing such changes as are met with in neurofibromas, multiple meningiomas, or simply hemangiomatous malformations. Regarding the latter, a case in point is that described by Cushing (25), in which an extensive trigeminal nevus was associated with hypoplasia of the gasserian ganglion on the same side.

Yakovlev and Guthrie (111) make the following pertinent statement:

"The histogenesis of vascular malformations as observed in angiomatosis of the central nervous system strongly suggests that, in these congenital anomalies which appear to be of mesodermal origin, there is also an ectodermal element, gliosis, which takes an active part, not as a secondary reaction but as a primitive glial process combined with vascular hyperplasia or even tumor formation."

Harbitz (56) finds little difficulty in accounting for the association of angiomatosis (mesenchymal dyscrasia), multiple neurofibromatosis (neuro-ectodermal tumors with mesenchymal elements), and gliomas (neuro-ectodermal tumors pure and simple). He points out that, on an embryologic basis, there is a close connection between ectoderm and mesoderm, and that there is little ground for the assumption that the mesenchyme has arisen entirely from a separate third germinal layer. Thus, in a series of cases of multiple tumors, he shows the comparatively frequent occurrence of multiple meningiomas with eighth nerve neurofibromas and with von Recklinghausen's disease; of hemangioma of the dura with hypophyseal adenoma; of von Hippel-Lindau's disease with syringomyelia, pancreatic cyst, and hypernephroma, and many others.

## CASE REPORTS

Since 1925, five cases of tuberous sclerosis have been identified at the Hospital of the University of Pennsylvania. Three of these have shown positive roentgen findings. Two of the five additional cases, available through the courtesy of Dr. Temple Fay, of Temple University, also show encephalographic evidences of the conditions which we feel are diagnostic.

Case 1. D. F., admitted to the University Hospital, service of Dr. Gittings, Dec. 14, 1938, to Jan. 21, 1939, with the complaint of constipation since two weeks of age and convulsions since the age of six months. Family history revealed no neuropathic taint. Birth was reported as normal but "long and tedious." Development had been entirely normal, the child being considered extremely intelligent. Past history was essentially negative. History of the present illness revealed that at six months of age, the child had a screaming attack. Following this, numerous mild attacks occurred in which the head was extended, with blinking of the eyes. These attacks occurred twice weekly until the child was two and one-half years of age. At this time, the attacks increased to eight and nine times during the night and were unaffected by 1/4 gr. of luminal. In August, 1938, incoördination affecting the left arm and leg was noted. Subsequently there was a period of four or five weeks in which no attacks occurred, following which the seizures increased in severity and frequency up to the time of admission. Physical examination revealed

Fig. 2. Case 1. The small subependymal mass is indicated at *a*. The right ventricle is larger than the left.

Fig. 1. Case 1. The shadows of the subependymal proliferations are seen at *a*. They may be closely associated with the choroid plexus.

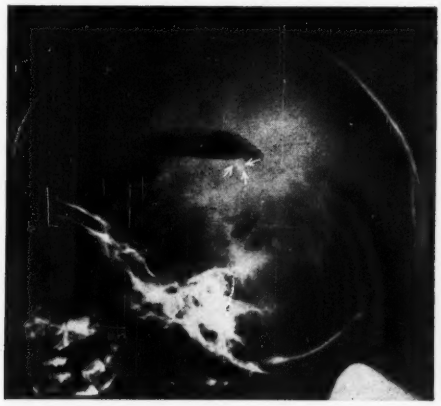

Fig. 3. Case 1. The twenty-four-hour examination shows the small intraventricular tumor indenting the fluid level in the right lateral ventricle

a well developed and nourished child, who was apprehensive and extremely uncooperative. During the examination the child had a petit mal attack lasting 45 seconds. On the skin of the face there were papular lesions of uncertain identity distributed in butterfly fashion over the nasolabial folds. Other positive data were: (1) large cryptic tonsils; (2) hesitancy in grasping objects with the left hand; (3) hypertonic reflexes in the legs, and hypotonic reflexes in the arms; (4) periungual wart on the left great toe; (5) inability to stand or walk, and (6) hypotonic body musculature. The neurologic examination showed bilaterally positive Babinski's. Funduscopically bilateral glistening plaques were seen in both retinæ. These were thought similar to the lesions seen in tuberous sclerosis. Bone age studies were normal.

On Dec. 20, 1938, pneumo-encephalography was done and a roentgen diagnosis of tuberous sclerosis made (Figs. 1, 2). The 24-hour examination showed the small intraventricular tumor indenting the fluid level in the right lateral ventricle (Fig. 3). The lateral ventricle on the right side was slightly dilated. This small nodule in the ventricle presented a rather unusual appearance, differing considerably from the unusual roentgenogram shown by Rigler (4), and the metastatic lesions previously reported by Learmonth and Camp (67).

Before the child was discharged to her local physician, a rather bizarre sugar tolerance curve was noted, as follows: Fasting, 40 mg. per cent; one-half hour, 176 mg.; one hour, 208 mg.; two hours, 244 mg. Examination of the urine at this time showed 4+ acetone. It was the opinion of Dr. Francis Lukens, of the University Hospital Staff, that, in diffuse brain lesions, especially those involving the hypothalamus, such disturbances in the carbohydrate metabolism were not frequently encountered.

Case 2. C. B., a white American schoolgirl, aged 16 years, admitted to the service of Dr. F. C. Grant, Neurosurgical Service of the Hospital of the University of Pennsylvania (Nov. 3 to Nov. 10, 1937), complaining of convulsions of two months' duration. The patient's mother had died at the age of 27 years of a brain tumor, and one of the patient's sisters had had staring attacks, which were relieved by luminal A maternal aunt had had attacks of rage and pallor, and one of the mother's cousins had had falling attacks. The patient did not show great mental retardation. Two years before the present admission the patient had had staring attacks. She did not, however, lose consciousness. Later, convulsive seizures supervened. These lasted for longer periods but occurred only once monthly up to the year before admission, when they became frequent during the day and also at night. Ten days before admission, she had had an attack lasting uninterruptedly for 36 hours and had had to be hospitalized. These seizures were only partially relieved by nembutal gr. 4; hyoscine hydrobromide gr. 1/100, hypodermicly, and sodium amytal gr. 7 1/2, intravenously.

Physical examination revealed an acneform eruption of the face. There was a bilateral nystagmus on lateral gaze. The patient was seen by Dr. L. Weinberger, on Nov. 4, 1937, when the following notation was made:

"The lesions of the face impress me as those pictured and described in tuberous sclerosis, the so-called adenoma sebaceum. The convulsive state and mild mental retardation complete the syndrome. While tuberous sclerosis is usually a pathological diagnosis, it can be made in the presence of the typical skin lesions. Occasionally the nodular ependymitis can be demonstrated by encephalography. Diagnosis: convulsive state, probably tuberous sclerosis."

Dermatologic consultation supported the above diagnosis.

Pneumo-encephalography was thought at first to be negative. When it was learned, however, that the patient had an adenoma sebaceum, the films were reviewed. Several small areas of calcification were noted lying in the region of the lateral ventricles. Stereoscopically a small

soft-tissue tumor was seen, projecting into the roof of the right lateral ventricle. Although the changes seen were slight, they were none the less definite, and the diagnosis was, accordingly, changed to "tuberous sclerosis." (Figs. 4, 5.)

Case 3. H. F., was first admitted to the Neurosurgical Department of the Hospital of the University of Pennsylvania, service of Dr. F. C. Grant (June 29 to July 6, 1938). The patient was a normally delivered, full term infant, eight weeks of age. Gestation had been normal except for polyhydramnios. One week after birth the mother noted an enlarged head.

Examination showed a marasmic infant of eight weeks; head enlarged, 18 inches; eyes turned down with exophthalmos. The right pupil was irregular, large, and fixed to light.

On July 5, 1938, a bilateral subdural puncture and ventricular tap was performed in order to demonstrate whether or not a communicating or non-communicating block existed. No fluid was found on bilateral subdural puncture. A ventricular tap was then done and indigo carmine

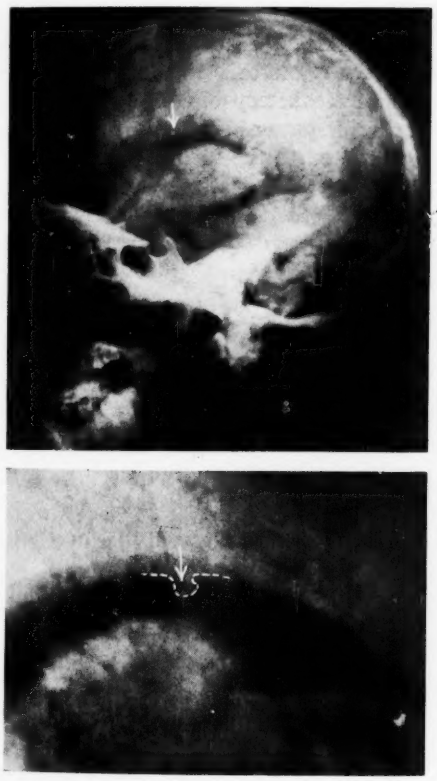

Fig. 4 (*upper*). Case 2. The small round dense lesion of tuberous sclerosis is indicated by an arrow. These lesions are readily overlooked unless careful search is made.

Fig. 5 (*lower*). Case 2. Close-up of the ventricle with the periphery of the tissue mass traced by an interrupted line.

Fig. 6 (*upper*). Case 3. Tuberous sclerosis. Note the marked internal hydrocephalus.

Fig. 7 (*lower*). Case 3. The postero-anterior view shows an almost complete absence of the cerebral cortex on the right, and it is quite thin on the left.

instilled. Lumbar punctures were performed on three occasions following this and no fluid was found. The diagnosis was obstructive hydrocephalus. The child was discharged unimproved.

Second admission (April 5–10, 1939) was for ventriculographic study. The child's head had been stationary in size for six months. Recently the child had been irritable, crying most of the time. On physical examination the head was found to measure 23 inches. The left hand and foot were smaller than the right, as were the arm and leg. The neurologic examination showed slight weakness on the left side of the body.

A ventriculogram was made on April 8, 1939. The roentgenograms showed a marked internal hydrocephalus with apparent left-sided hemiatrophy. There was almost complete destruction or hypogenesis of the right cerebrum. The left cortical tissues were also quite thin, but were approximately three or four times the thickness of the right. The marked hydrocephalus on the right produced secondary changes in the right half of the skull, which was larger than the left (Figs. 6, 7). Following the ventriculogram the cortex ruptured, letting air and fluid out into the subarachnoid space. The child ran a postoperative temperature as high as 104 degrees, became cyanotic and apneic, and died on April 10, 1939.

Necropsy revealed absence of the corpus callosum, microgyria, and sclerotic patches distributed over the surface of the brain. On the right side the basal ganglia were transformed into a stony hard tumorous mass. Numerous subependymal nodules were present, projecting into both lateral ventricles. The microscopic study was typical of tuberous sclerosis, showing giant cells, marked disturbance in the cytoarchitecture, and only vague demarcation between the cortical gray and the white matter. Dense areas of glial feltwork were also found, as well as islands containing, for the most part, plump astrocytes. In some areas psammoma bodies were identified. The histologic diagnosis was tuberous sclerosis (Figs. 8, 9).

Case 4[4] (courtesy of Dr. Temple Fay). J. I., a nine-year-old Polish-American boy was admitted to the Neurological Department of the Hospital of Temple University (May 15 to June 2, 1932). Chief complaint was convulsions, since the age of

[4] For detailed history of this case see report of Drake (35).

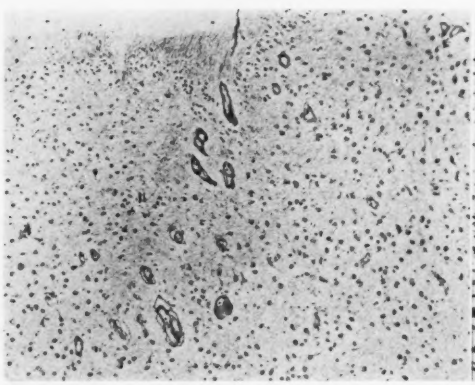

Fig. 8.

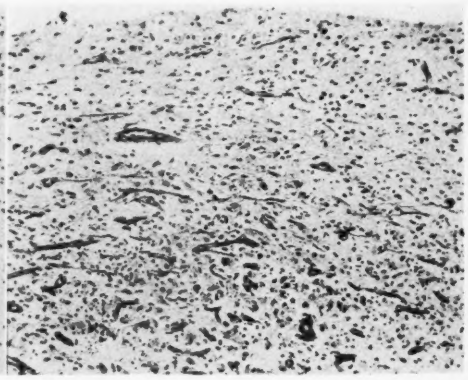

Fig. 9.

Fig. 8. Cortical nodule in tuberous sclerosis. Complete loss of cortical architecture. Nerve cells are not well defined with the exception of one giant cell. In the subpial layer, Cajal cells and dense glia fibers in brush-like arrangement are visible.

Fig. 9. Subependymal nodule of the optic thalamus in tuberous sclerosis projecting into the ventricular space. Marked vascularization of the subependymal layer with accumulation of undifferentiated spongioblasts.

four. These were associated with visual hallucinations, respiratory difficulties, and vertigo, but there was no nausea or vomiting. Three years before admission the boy had complained of bilateral parietal headache. On neurologic examination a mild hemiparetic gait was evident, and there were mild positive cerebellar signs, as brought out by the finger-to-nose test. Examination of the fundi showed an anomalous elevation of the upper halves of both optic discs, but there were no phacomas.

Roentgenographic examination of the skull showed several discrete masses of calcification in the left occipital region and another small calcareous deposit on the right side of the skull. It was thought by Dr. A. K. Merchant that these represented multiple calcifications within the brain substance. A pneumo-encephalogram was carried out by the spinal route and the calcifications were again noted. In addition there was encroachment upon the right lateral ventricle in all views, the appearance simulating that seen in brain tumor (Figs. 10, 11), *but there was no evidence of shift of the midline structures.* After consultation with Dr. Fay and his Staff, the following conclusions were reached by Dr. W. E. Chamberlain:

"All things considered, I feel the upward displacement of the cisterna venæ magnæ cerebri and the bulging of the right thalamus into the

Fig. 10. Case 4. Postero-anterior view showing the small right ventricle, producing an appearance similar to that seen in brain tumor without evidence of mid-line shift. (*Shown through the courtesy of Dr Temple Fay and Dr. W. Edward Chamberlain.*)

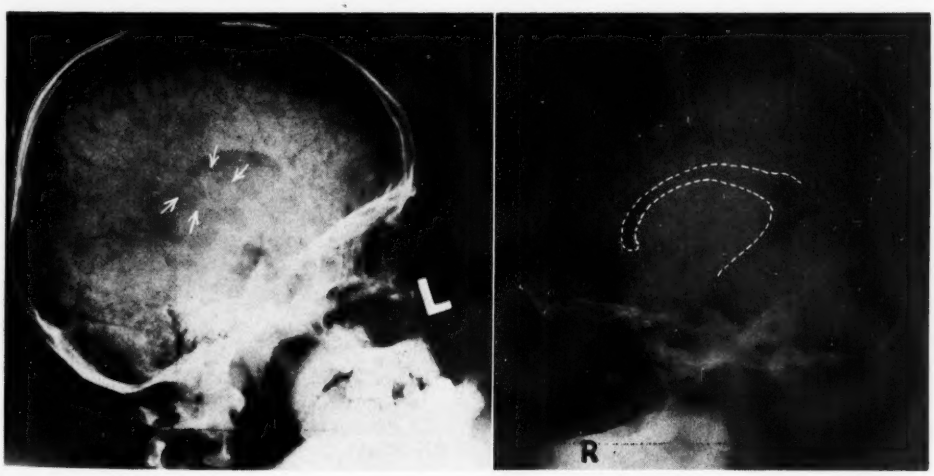


Fig. 11. Case 4. Lateral views of the same case as that shown in Figures 10 and 12, showing encroachment on the lateral ventricle.

right lateral ventricle are definite. The more I study the air pattern over the convex surface the more I consider the possibility of a microgyria. It is very significant that the septum pellucidum is displaced toward the right instead of toward the left. It is also very significant that the cisternæ at the base are increased in size instead of decreased, and there is general increase in the subarachnoid fluid volume instead of a decrease, as might be expected in a case of glioma. For the above reasons it appears we are dealing with a case of tuberous sclerosis."

The finding of a bulging of the thalamus into the right lateral ventricle without a midline shift can readily be accounted for if we know we are dealing with a hemartoma. In other words, we are dealing with a congenital ectopia, the neoformation occupying the position ordinarily taken by normal brain substance and, therefore, not displacing it. Thus the anomalous finding is explained. One other point deserves mention and that is the appearance of the intraventricular tumefactions which are present in the anteroposterior film. This appearance, in our experience, is found only in the neuro-ectodermoses, and we feel that the finding may be taken as strong evidence in favor of the diagnosis of tuberous sclerosis, or its allied conditions, even in the absence of an adenoma sebaceum (Fig. 12).

Case 5 (courtesy of Dr. Temple Fay). G. G., aged fifteen months, was admitted in April, 1937, and discharged in May, 1937. Chief complaints were enlarged head, retardation in walking and talking, irritability. No adenoma sebaceum was found. The neurologic examination was essentially negative. A pneumo-encephalogram was carried out and showed two space-taking lesions, one in the third and one in the fourth ventricle. The soft-tumor mass in the third ventricle was in the region of the middle commissure (Fig. 13). Three possibilities were listed by Dr. Barton Young: tuberous sclerosis, tuberculosis, and metastatic meduloblastoma. The final diagnosis was multiple lesions, etiology unknown. In view of the lack of proper development in the case of this child, and the unusual finding of multiple intraventricular tumors, it seems more than likely that we are also dealing here with a case of tuberous sclerosis,

Fig. 12. Case 4. The small masses of tuberous sclerosis are shown within the shadow of the ventricle. (*Shown through the courtesy of Dr. Fay and Dr. Chamberlain.*)

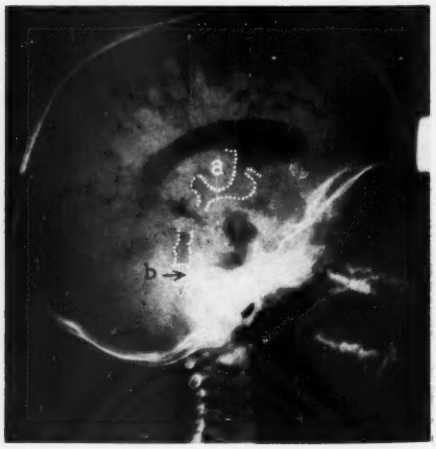


Fig. 13. Case 5. Lateral view showing a soft-tissue mass at *a* which corresponds to the position of the middle commissure. There was also a lesion at *b* in the fourth ventricle. (*Shown through the courtesy of Dr. Fay and Dr. Chamberlain.*)

metastatic cancer and multiple tuberculomas being less probable alternative possibilities.

### NEUROFIBROMATOSIS

This entity is too well known to warrant giving more than a brief summary of its noteworthy clinical features. The outstanding finding, in the classical case, is the large number of fibromas mollusca which may cover the cutis so extensively that, in the advanced cases, the individual is hardly recognizable. Pigmentary disorders are also frequently met with in the form of pigmented moles, or the so-called "café au lait" spots, which, in the early form of the disease, may afford the only clue to diagnosis. This phase of the subject has recently been dealt with by Leader and Grand (66). Patches of vitiligo, the anemic nevi of Voerner, are not infrequently encountered. In addition to these cutaneous changes, any or all of which are occasionally found in the related syndrome, tuberous sclerosis, may be found numerous subcutaneous tumors, frequently painful, involving multiple nerves. If a peripheral nerve, together with its branches, is affected, the result is a typical cirsoid nevus, or plexiform neuroma. These frequently occur in the trigeminal area and, as pointed out by Schinz, *et al.* (91), Case (18), and Pack (84), are associated with changes in the adjacent osseous structures. According to Grinker (54), uniform enlargement of the nerve trunks has been designated "familial, interstitial, hypertrophic neuritis."

This entity is frequently associated with eighth nerve tumor and other cranial nerve tumors, such as the vagus, trigeminal, optic, and hypoglossal, as well as gliomas of the brain. Aegerter and Smith (1) state that the tumors must arise either from axone tissue, sheath of Schwann, or the mesoblastic elements closely connected to them, that is, (*a*) the epineurium, (*b*) the perineurium, or (*c*) the endoneurium. Their case report is of interest because it describes the condition alluded to above by Grinker. At necropsy they discovered a bipolar type of spongioblastoma involving the hypothalamus, a bulbous mass in the chiasm and hypertrophic changes affecting multiple cranial and peripheral nerves. Numerous tumors were found throughout the mesentery; these plaques, histologically, were composed of axone elements. The peripheral nerve tumors appeared to be composed, for the most part, of fibroconnective tissue elements, while the

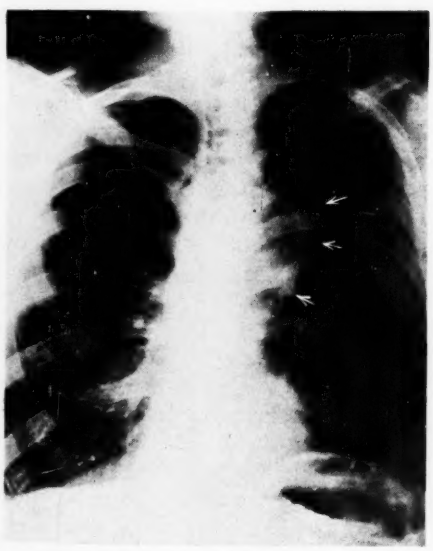

Fig. 14. Case 6. Mediastinal neurofibroma. This might readily be mistaken for any other type of mediastinal mass lesion.

Fig. 15. Case 6. Multiple neurofibroma involving the bones of the pelvis at *a* and *b*.

changes in the ganglia and trunks of the sympathetic plexuses resulted from hyperplasia of the Schwann cells (neural crest elements). On reading their case, one is impressed by the finding of the bipolar spongioblastoma in the brain, as this type of tumor is not infrequently encountered in tuberous sclerosis, as has been shown by Globus (48), and Ferraro and Doolittle (39).

The osseous changes in neurofibromatosis have recently attracted considerable attention. Hodges, Phemister, and Brunschwig (57) in their excellent treatise report that skeletal lesions are found in 7 per cent of the cases. They point out that...

"the most typical bone lesions are rounded, cyst-like structures, projecting from the cortical surfaces, usually near the ends of the long bones. The cortex beneath them is usually perforated, but the projecting portion of the lesion may carry a thin coating of cortical bone. The lesion is said to begin as a neurofibroma of a periosteal nerve and to destroy the neighboring bone by pressure rather than invasion . . . biopsy of such lesions shows that structures which look like cavities in roentgenograms are pits filled with fibrous tissue. In older lesions, it may be difficult or impossible to demonstrate neural tissue elements among this fibrous tissue."

Brooks and Lehman (9) were among the first to report the "bone changes in von Recklinghausen's neurofibromatosis" in the American literature. They noted the following points:

(1) Curvature of the spine (a kyphoscoliosis of the spine is almost invariably met with in this disorder)
(2) Abnormalities in growth, such as hyperplasia and hypoplasia of the extremities
(3) "Irregularities of outline of the shafts of long bones including changes which in the x-ray film appear as subperiosteal bone cysts."

Among the positive roentgen findings reported in their cases were the following: scoliosis, cyst-like cavities in the heads of the femora, hyperostoses of the ilium with a somewhat cystic appearance, lengthening of the long bones, periosteal egg-like tumefactions of the bones with a thin cortical shell, bowing and irregularity of the long bones, and coxa valga associated with hypoplasia. It was the opinion of Brooks and Lehman (9) that in cases in which excessive growth in length of the bone had occurred in this disease, it was usually associated with a congenital elephantiasis. Norgaard (80), however, in a recent publication, is of the opinion that differences in length of bones can be accounted for on the basis of an embryogenic defect. Whatever the theoretical cause for the overgrowth may be, von Recklinghausen's disease must be considered as a factor in the causation of bone and soft-tissue hyperplasia. Other agents which may produce a similar picture are listed by Norgaard as follows: (1) congenital lymphangiomas and hemangiomas; (2) chronic venous and lymph stasis; (3) arteriovenous fistula and inflammatory states, such as osteomyelitis; (4) inflammations and tumors involving joints and soft-tissue structures, and (5) increased longitudinal growth following fractures.

Recent articles from the German literature dealing with the osseous changes in von Recklinghausen's disease are those of Kienböck and Mayer (61), Faberow (36), and Norgaard (81). Kienböck and Mayer have reported the finding of multiple cysts in the transverse processes of the involved vertebræ, while Mayer has discussed the relationship between sella turcica enlargement and the disease. He believes enlargement of the sella occurs most frequently in those cases which show involvement of the orbit by the morbid process.

The following case is noteworthy of report because of the large osteolytic lesions found roentgenographically in the pelvis, as well as the mediastinal tumor found in the left hemithorax. It is of further interest that the neurofibromas apparently underwent sarcomatous change, ultimately causing the death of the patient. Such a change is met with in approximately 22 per cent of cases (58).

Case 6. W. I., 41-year-old white male, was first admitted to the Medical Service of the Hospital of the University of Pennsylvania (Nov. 6 to Dec. 17, 1936). His chief complaint was a knife-like pain in the right thigh and leg. This was of three months' duration and increased in severity while standing. A left-sided sciatica had been present for two months. The patient also complained of considerable pain in the left hip. An additional complaint was that of cough and "asthma" of 12 years' duration. His past history was negative, except for the appearance of multiple skin nodules early in life. The right eye had been removed following trauma in 1922. Poor vision was subsequently noted in the left eye and failed entirely in 1923. Review of various systems was negative, except for weakness and loss of appetite of three months' duration. Physical examination revealed a well developed and nourished adult male, evidencing numerous cutaneous nodules. These varied in size from pinhead to an inch or more, some projecting above the epidermis as much as three-fourths of an inch. Several "café au lait spots" and hemangiomas were found scattered over the trunk. The chest was filled with crackling râles on either side. Some fullness was noted in the region of the right obturator foramen on rectal examination. Laboratory studies revealed largely negative findings.

Roentgenographic examination of the chest showed a large nodular mediastinal tumor, projecting out into the inner third of the left lung-field, and an *S*-shaped scoliosis of the dorsal spine (Fig. 14). From the roentgen appearance it was thought that a bronchiogenic tumor could not be entirely excluded. A diagnosis of enlarged mediastinal lymph nodes was made on the basis of the roentgen appearance, etc. In the light of the clinical findings, however, which included a positive skin biopsy for neurofibromatosis, this view had to be modified, and it was felt that the lesion was undoubtedly a neurofibroma, having its origin from one of the mediastinal nerves. Examination of the pelvis showed striking changes (Fig. 15). There was a large osteolytic roughly circular lesion, with scalloped borders, which occupied the left wing of the ilium. On the right the horizontal ramus of the pubis had been entirely destroyed. The roentgenograms were discussed at a conference of roentgenologists and the consensus of opinion was that, in view of the remarkable bone erosion and the chest tumors, malignant metaplasia had occurred. Roentgenograms taken of the spine showed no erosion of the intervertebral canals, or widening of the interpedicular spaces. Examination of the bones of the extremities showed numerous small subcutaneous soft-tissue tumors and possible

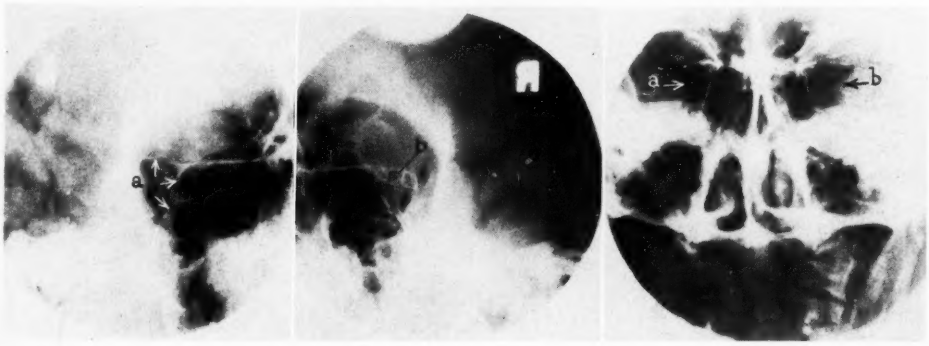


Fig. 16. Case 7. Neurofibroma of the left optic nerve. The shadow of the normal optic canal is seen at *b*. Compare this with the left at *a*. The optic canal on the left side is enlarged and has encroached upon and caused an enlargement of the supra-orbital fissure at *b* in the postero-anterior view. The usual normal appearance is seen at *a* in the same view.

early cystic changes in the upper third of the right humerus. It was felt that, while biopsy of the bone lesions would be interesting, it would be unnecessary as far as the diagnosis was concerned, in view of the fact that skin consultation and tissue study had shown that we were dealing with a classic case of von Recklinghausen's disease.

Deep roentgen therapy—both the chest and pelvic lesions receiving irradiation—was given a thorough trial, but without perceptible benefit or change in the character of the lesions. The patient's subsequent clinical course confirmed the prediction that metaplasia had taken place, as he died at his home on June 14, 1939, at which time a diagnosis of generalized sarcomatosis was made.

Neurofibromatosis involving the orbit has been considered by LeWald (70) and more recently by Wheeler (109), and Pancoast, Pendergrass, and Schaeffer (85). Although this is not the most frequent cause for pulsating exophthalmos, it should not be forgotten that a dehiscence in the orbital wall, if of sufficient size, produces a communication between the orbital and cranial cavities, resulting in a unilateral exophthalmos pulsating synchronously with the radial artery. In one of the cases reported by Wheeler (109), "the pulsation had led the surgeon to ligate the carotid artery in the belief that the orbital mass was of a vascular nature." An interesting clinical finding in these cases is the fact that the pulsation does not annoy the patient, because of the absence of bruit. In those cases of orbitocranial communication resulting from arteriovenous aneurysm (Wheeler), the bruit is very distressing. Clinically, in the form due to von Recklinghausen's disease, pulsation is often readily apparent, while in arteriovenous communication it is not ordinarily appreciable to the unaided eye.

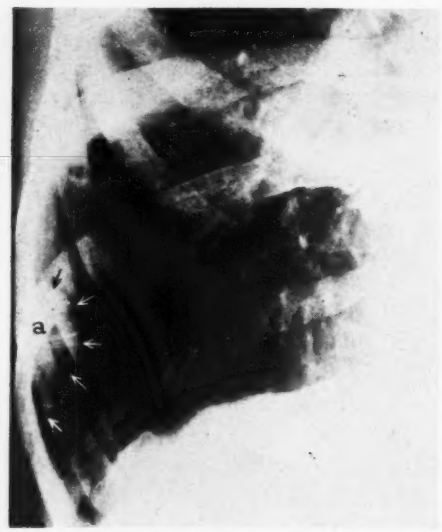


Fig. 17. Case 7. The soft-tissue mass in the right lower chest was thought to be a neurofibroma similar to that found in other parts of the body.

The following is a rare case of orbital wall destruction in a patient with proven neurofibromatosis.

Case 7. J. G. S., 59-year old American night watchman, was admitted to the Pepper Ward of the Hospital of the University of Pennsylvania (May 12 to June 5, 1939). Chief complaints were a dull dragging sensation in the left upper abdomen of ten years' duration and a protrusion of the left eye of nine months' duration. History of present illness: (The patient tended to be nervous and emotional, in view of which the anamnesis may be accurate only in part.) The dull, dragging left-sided abdominal pain was occasionally relieved by the ingestion of sodium bicarbonate, which often induced vomiting. Associated with this there was some vague right upper quadrant distress. For three years the patient had noticed some loss of appetite. Nine months prior to admission he also noticed inability to turn the left eye laterally and some double vision. Protrusion of the left eye was noticeable also at this time. Family history was noncontributory. Physical examination revealed a marked proptosis of the left eye with ptosis of the left lid, causing a narrowed palpebral fissure on this side. Associated with this, there was evident a paralysis of the external and superior rectus, as well as the inferior oblique. Funduscopic examination showed some

swelling and haziness on the nasal side of the disc. Examination of the neck showed some fullness in both supraclavicular fossæ; pressure on these areas caused some pain and tingling in the hands. The chest, lungs, and heart were essentially negative. Over the right triceps muscle there was a firm non-tender nodule, the size of a pullet's egg. Other nodules were found on the dorsum of the left foot and in the left popliteal fossa. The clinical impression was: "Mass behind the left globe causing proptosis; question of neurofibromatosis or sarcomatosis." Further examination disclosed numerous other subcutaneous tumors, some of which were hard and fibrous, while others appeared to have the characteristics of lipomas and lymph nodes. Laboratory studies were negative, except for an elevated cholesterol. Temperature, pulse, and respiration were normal.

Roentgenographic studies of the long bones showed no evidence of von Recklinghausen's disease. A small rounded nodule was noted in the soft tissues of the left arm. Examination of the head and optic canals revealed a pathologic process involving the left orbital wall. The report of the roentgen examination by one of the authors is given herewith:

"There is no evidence of increased intracranial pressure. The pituitary fossa is within normal limits and measures; ap. 10 mm., depth 8 mm. There is physiologic calcification of the pineal and both choroid plexuses. In the postero-anterior film of the skull the superior orbital fissure on the left side is considerably larger than that on the right. Films of the optic canals show destruction of the inferior and lateral walls of the optic canal on the left. One of two things may have happened in this area, either there is a pathologic process or there has been non-development of the orbital wall, as described by LeWald. Most of LeWald's cases were associated with von Recklinghausen's disease." (Fig. 16.)

Films of the chest showed a nodular tumor arising from the pleura in the right hemithorax, and a healed bilateral pulmonary tuberculosis (Fig. 17). Cholecystogram and gastro-intestinal examinations were negative. A urogram revealed a left-sided renal calculus, with deformation of the calices on both sides.

A biopsy of one of the skin nodules was positive for neurofibroma of von Recklinghausen. It was the opinion of the eye consultants (Staff of Dr. F. H. Adler), however, that, in view of the fact that cancer had not been definitely excluded, exploration of the orbit should be postponed and the patient examined at intervals for field or visual defects and for progression of the proptosis. The patient was, therefore, transferred to the Urological Service for a left-sided pyelolithotomy, which was performed on June 6, 1939. The patient made an uneventful recovery and was discharged for follow-up on June 27, 1939.

The association between eighth nerve tumors and von Recklinghausen's disease is well recognized. Certain features, perhaps less well known to roentgenologists than to neurologists and neurosurgeons, deserve mention at this time. It should first be emphasized that eighth nerve tumors almost invariably arise from the

Fig. 18. Case 8. Bilateral acoustic nerve tumors. The shadow of the erosion of the acoustic area is seen readily at *a* on the right side, but on the left side it has been necessary to outline the eroded area by interrupted lines and arrows. The petrous ridge on the left is also outlined.

vestibular component of the nerve. Skinner (97) points out in his excellent study of the origin of acoustic nerve tumors that the characteristic cell is the *neurilemmablast*, arising only in the peripheral portion of the nerve, and having its origin from neural crest. According to Skinner, the central, or glial, portion of the nerve is never primarily involved in the neoformation. The junction of the peripheral and central portion of the nerve may be considered to lie at the porous acusticus internus. A second point worthy of consideration by the roentgenologist is the frequency with which bilateral lesions are encountered, particularly when cutaneous manifestations are evident. This feature has been particularly well emphasized by the classical study of Gardner and Frazier (42). These men found, in a review of the literature at that time, a total of 37 (bilateral) cases associated with other stigmas of von Recklinghausen's disease, and only seven (bilateral) cases which were apparently unassociated with cutaneous symptoms.

In a report of bilateral eighth nerve tumors, De Klejn and Gray (32) state:

> "The bilateral symmetry. . . is interesting and might be expected to be unusual. As a matter of actual fact, however, when neurofibromatosis (von Recklinghausen's disease) affects the auditory nerve it is by no means unusual to find a tumor on each side. Of course, when a tumor of the auditory nerve occurs independently of neurofibromatosis, it is almost invariably unilateral."

Cushing and Eisenhardt (27) are of the opinion that the bilateral tumors are more slowly growing and thus may differ considerably in their life history from the unilateral lesions and surgically appear to be more readily enucleable. In most instances (90 per cent of cases) the neurinomas and true neurofibromas can be differentiated from histologic studies. In cases in which the criteria of Penfield (86) exist, *i.e.*, preformed nerve fibers penetrating the tumor, there can be little doubt that one is dealing with a neurofibroma.

From the practical point of view, however, the radiologist needs to concern himself with a careful examination of *both internal meati, especially if skin lesions are present.* His attention should next turn more laterally, to the region of the cochlea and semicircular canals, where an expansile lesion may not infrequently be demonstrated. Undulations along the superior surface of the petrous, in the routine Towne position, may offer confusion to the student. These have been described by Pancoast, Pendergrass, and Schaeffer (85). Minor, and sometimes even major, differences along this surface on the two sides can be accounted for in many instances on the basis of an anatomic variation, especially when there is no evidence of demineralization. When there is a loss of bone-line density, however, and wiping out of the cortical bone in this region or at the apex, a pathologic condition must be considered. Another point worthy of consideration has recently been stressed by Camp and Cilley (16). They state that, although the normal average diameters of the pori acustici is of the nature of 5 mm., maximal variations as high as 11 mm. may occur normally. They found, further, that variations between the two sides of as much as 2.5 mm., while rare, might also normally occur.

In instances in which there is no roentgen evidence of tumor, in the face of exact neurologic localizing signs, we cannot consider that we have excluded eighth nerve tumor. As has been stressed in this country by Lewy (69), the neurinoma which lies intracranially, mesial to the porous, and causing no bony erosion, will be the one which can be attacked most successfully by radical surgery. The neurofibroma arising in the cochlear whorls and destroying the internal ear, with roentgen evidence of elevation of the petrous roof, lends itself less readily to surgical extirpation, and can ordinarily be attacked only piecemeal, by multiple decompressive operations. The limitations of diagnosis in this field have previously been well discussed by Gershon-Cohen (44).

Case 8. The following case report from

the service of Dr. F. C. Grant serves to illustrate some of the features discussed above. A 39-year-old white American was first admitted to the service of Dr. C. H. Frazier, Hospital of the University of Pennsylvania (Oct. 28 to Dec. 12, 1939), with chief complaints of pain behind the right ear, over the forehead, both eyes and temples; bilateral deafness, more marked on the right; numbness of the left cheek and jaw, and staggering gait. The deafness and pain had been present for approximately three years. The patient was studied in the hospital for several days, with physical examination and neurologic studies—both normal. Roentgenograms suggested a possible angle tumor, but, because of bilateral Bárány findings, the patient was discharged. Diagnosis: bilateral labyrinthine disease.

Upon second admission (July 17 to Aug. 27, 1933), there had been no improvement in the patient's symptoms in the interim. Neurologic examination at this time revealed multiple cranial nerve involvement, bilaterally. The fifth and eighth nerves were involved on both sides, and, in addition, the sixth and seventh nerves were involved on the left. A diagnosis of bilateral acoustic tumors was suggested. Syphilis was excluded at this time by a provocative Wassermann. The patient was discharged to wait for return of symptoms and exploratory operation.

At the time of third admission (April 29 to May 6, 1936) there was a complaint of staggering gait, numbness of the forehead, and nystagmus. Diagnosis remained bilateral degenerative labyrinthitis. It was felt, by some, that the long duration of the symptoms had excluded a cerebellopontine angle tumor.

Upon fourth admission (Oct. 5 to Oct. 18, 1937) the patient was admitted with the original symptoms plus increased unsteadiness in gait and blurred vision. Physical examination showed several small subcutaneous nodules in the thoracic region and over the abdomen. Roentgenograms revealed bilateral processes involving the petrous of each temporal bone (Fig. 18). On the right side the roof of the petrous was entirely destroyed, while on the left there was evidence of an osteolytic lesion which had expanded the labyrinth and raised the petrous roof above. Roentgen diagnosis: "probable bilateral acoustic neurofibromas." Neurologic examination revealed a labile personality, slurred speech, positive Romberg, reduced vision, bilateral choked discs, impairment of pain, temperature, and touch sensations on both sides of the face, right facial weakness, bilateral deafness, and loss of taste on the anterior two-thirds of the tongue.

The clinical diagnosis was confirmed by exploratory operation, carried out by Dr. F. C. Grant on Oct. 16, 1937, at which time a suboccipital craniectomy was performed under amytal, avertin, and novocaine anesthesia. The following pre-operative comment by Dr. Grant is of interest:

> "This man is the father of a boy on whom I operated some three or four years ago, who had von Recklinghausen's disease, with a tumor of the spinal cord, and a fibrous tumor on the inside of the knee. This man has obvious evidence of bilateral tumors, and while it would be very difficult to remove these tumors, I thought we could at least decompress him and save some of his vision."

At operation bilateral angle tumors were found, a wide decompression secured, and several large pieces of tumor removed for identification. Histologically, these proved to be typical neurofibromas, showing palisading of the cells, and preformed nerve fibrils in the center of the tumor (Dr. B. J. Alpers). The patient did well, post-operatively, for 24 hours, following which he developed atelectasis of the left lower lobe and died of a fulminating pulmonary infection. Unfortunately permission for necropsy was refused.

*Roentgen Findings in Vascular Tumors of the Brain.*—An important conception in the understanding of vascular tumors of the cerebrum is the finding of most malformations supratentorially, and most neoformations subtentorially. The malformations, such as the cavernous angiomatosis of the brain, which occurs above the tentorium, are frequently associated with tri-

geminal nevus and congenital buphthalmos. These frequently calcify, giving rise to a typical roentgen appearance showing whorls of calcium distributed in the post-rolandic area. Often, as has been pointed out by Schwartz (92), the lesions may also occupy the frontal lobe. The typical angioblastoma of the cerebellum, however, is a true newgrowth, and as Arvid Lindau (72) has shown, is associated with an entirely different form of ocular lesion. In this case there are no congenital changes involving the anterior chamber and canal of Schlemm, but, instead, a true hemangioma of the retina (von Hippel's disease) occurs in 25 per cent of the cases. In addition, associated lesions may be found in the medulla oblongata and spinal cord, with cystic lesions in many of the abdominal viscera, such as the kidneys, liver, and suprarenals. The widespread character of the disturbance in this disease thus closely parallels many of the features of tuberous sclerosis, which we have already noted. Roentgen changes, however, are extremely infrequent in this disorder, although recently intra-orbital roentgen changes have been reported by Davison, Brock, and Dyke (30, page 16).

Fig. 19. Case 9. Intracranial calcification case. (*Shown through the courtesy of Dr. Bernard Widmann, of the Philadelphia General Hospital.*) Note the sinuous appearance of the calcium deposit due to the deposition in the various gyri.

It is rather surprising, when one considers the complicated embryologic development of the vasculature of the region of the head, that the malformations account for but 2 per cent of the intracranial neoplasms. According to Schwartz (92), the angular and supramarginal gyri in the parietal region are most frequently involved, the angiomatosis in most instances spring from the middle or anterior cerebral vessels. In his excellent review of the subject, he has pointed out that the calcification can be distinguished from a calcified glioma by the character of the deposit which frequently arranges itself in parallel streaks or in circles. Schwartz has also pointed out that in angiomatosis evidence of increased intracranial pressure and erosion of the dorsum sellæ are usually lacking. One can likewise distinguish the vascular anomalies from meningiomas on the basis of age, angiomatosis being found much more frequently in younger patients.

The malformations consist of arteries, veins, or capillaries, the latter or telangiectatic variety being rarely if ever diagnosed by the roentgenogram (Schwartz). The vessel walls are extremely thin. This is particularly true of the venous variety, in which the endothelium rests directly against a connective tissue base without the intervention of the media (12). Such changes naturally predispose to hemorrhage. Calcium deposition occurs in a high percentage of these tumors, but when present is not necessarily limited to the vessel walls, for, as has been pointed out by Krabbe (64), it may also be present in "numerous small, mostly microscopic, granules of lime salts, localized in the second and third layers of the cortex." In these areas atrophic changes have taken place in the nerve tissue and the normal ganglion cells are replaced by fibrillar neuroglia. These atrophic phenomena are of considerable importance since they account for the unilateral ventricular dilatation not infrequently met with in the encephalogram. They also act as an important limiting factor in instances in which roentgen therapy is concerned, for,

as has been stressed by Bucy (12), the roentgen ray can be counted on to effect a thrombosis of the vessels due to an obliterative endarteritis, although it cannot be hoped, under any circumstances, to alleviate the condition of cerebral atrophy or maldevelopment. In certain instances, when surgical interference appears to be contra-indicated, worthwhile results can be expected from roentgen therapy. An example is Cushing's Case 14 (26). This patient had an audible bruit which disclosed the presence of an arteriovenous communication. Following irradiation the bruit disappeared and the patient became symptom-free over a follow-up period of six years.

The frequent association of trigeminal nevus with supratentorial angioma and "china eye" has been recognized for many years. In 1906, Cushing (25) reported his operative experience with several cases. He called attention to the fact that a definite relationship existed between the trigeminal innervation of the meninges and face and the occurrence of vascular nevi in these situations. In Case 1, reported by Cushing, the bone flap was so vascular that operation had to be abandoned. He noted, however, considerable atrophy over

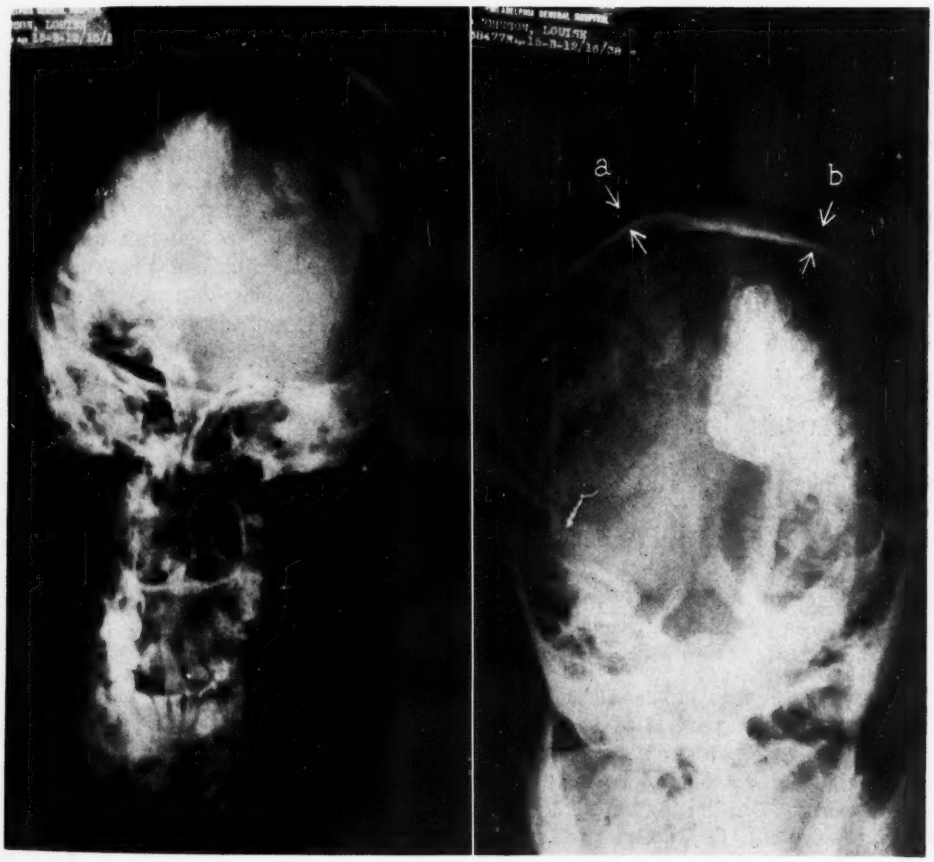


Fig. 20. Fig. 21.

Fig. 20. Case 9. Postero-anterior view showing the calcification and evidence of hemiatrophy.
Fig. 21. Case 9. The hemiatrophy and calcification are well shown. The thickness of the bone at *a* and *b* is about the same.

the right occipital lobe, as well as over the right central convolutions. The gasserian ganglion on the same side was hypoplastic.

Recently Krabbe (64) has summarized the symptomatology of the syndrome as follows: "Epileptic seizures and port-wine stain angiomas of the face are characteristic. Associated with this are the frequent additional symptoms of mental defect, contralateral spastic hemiplegia, and not infrequently, obesity of endocrine origin." The author suggests the use of "Parkes-Weber-Dimitri's disease" as the proper name for the syndrome.

Foster Moore (79) has listed the ocular dysfunctions which may be met with clinically in association with intracranial nevus as follows:

(1) Congenital buphthalmos (hydrophthalmos or glaucoma), *i.e.*, a glaucoma which dates early in life, at which time the external coat of the eye is still relatively elastic, allowing for the formation of typical "ox-eye." This is due, according to Treacher Collins (21), to congenital changes at the angle of the anterior chamber obstructing the free egress of the intra-ocular fluids.

(2) Heterochromia iridis, heavy pigmentation of the iris on the side of the facial nevus.

(3) Coloboma of the disc and melanoma of the choroid. If such findings become evident on funduscopic examination, a roentgenogram of the skull should be taken to exclude a calcified angiomatous malformation.

Among those who have figured prominently in reporting cases of intracranial angioma with or without contralateral hemiplegia and cerebral calcification are the following: Dimitri (34), Marque (75), Moore (79), Weber (107), Greig (52), Lévy (68), and Brushfield and Wyatt (11). Hugo's (59) case report is also of interest because at necropsy a "nodular ependymitis" involving the intraventricular system was found. It thus becomes apparent that, in any or all of the neurocutaneous syndromes, intraventricular tumors can be found by cerebral pneumography. Yakovlev and Guthrie (111) have already shown the occurrence of intraventricular "candle gutterings" in a case of von Recklinghausen's disease.

The following case is reported not only because of its great rarity but also because it represents one of the most advanced forms of intracranial disease which we have encountered.

Case 9. L. J., negress aged 17 years, was admitted to the Philadelphia General Hospital for treatment of a discoloration of the left side of the face. This had been present since birth. Physical examination revealed a large, trigeminal nevus, involving the left side of the face as well as the upper and lower lips. The intra-oral structures on the left side were also involved. There was a history of "strokes" since the age of three. Vision had been gradually failing since that time. Neurologic examination revealed a hemiparesis of the right side involving the arm and leg, which had developed contractures. The patient was examined by the ophthalmologists on Dec. 12, 1938, at which time a diagnosis of bilateral glaucoma was made. A brief neurologic survey was reported as follows:

"This patient's mentality is very poor. Although she has never gone to school she has been able to learn a few things. No delusions, hallucinations, or behavior difficulties. The pupils are equal but sluggish. The right disc is easily seen and is normal in outline. The left disc is not seen. No corneal anesthesia. It is difficult to determine but the left side of the face is weaker than the right. No facial anesthesia. Other cranial nerves negative. There is spastic hemiplegia on the right, with flexion spasm of the right wrist. The reflexes are hyperactive in the right arm and leg. There is an equivocal Babinski on the right with an increase in tone and partial foot-drop on the same side. Sensory examination is essentially normal. The gait is typically hemiplegic in character. Unquestionably, old cerebral vascular condition. The findings are most likely due to repeated cerebro-vascular insults."

The roentgen examination showed exten-

sive calcification in the left hemisphere with evidently considerable cortical atrophy on the left side. (Figs. 19, 20, and 21.) The left frontal sinuses were unusually large; poor development on the right. The mandible on the left side was also longer and more developed. Roentgen diagnosis: extensive cortical atrophy with calcification and compensatory enlargement of the left frontal sinus, mastoid and antrum.

The parents refused to have the patient return for further study and consequently pneumo-encephalography could not be performed.

## COMMENTS

An effort has been made to review the literature on the neurocutaneous disease and discuss those phases of the subject that might be of interest to the radiologist from the standpoint of diagnosis and therapy. It is interesting to recall that this entire subject was brought to attention for study and investigation through the reference of a little girl to us for treatment of a periungual fibroma.

The subject is presented as four entities, which are: tuberous sclerosis, von Recklinghausen's neurofibromatosis, angiomatosis cerebri, and von Hippel-Lindau's disease. The roentgen examination in these various conditions will often show changes that are of immense diagnostic importance.

The authors wish to thank Temple Fay, M.D., and W. Edward Chamberlain, M.D., of the Temple University Hospital, for their permission to include some of their cases in this report.

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# THORIUM DIOXIDE AS AN AID IN THE DIFFERENTIAL DIAGNOSIS OF PYLEPHLEBITIS[1]

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WE have employed the use of thorium dioxide intravenously since 1932. In most instances it was used to aid in determining the presence of tumor or suppuration in the liver, and in those cases which survived the original illness, we have failed to observe any permanent harmful effects of the drug.

Damaging effects to the tissues of experimental animals have been reported (1, 2, 3, 4) and its use in man has been discouraged because of its prolonged retention in the reticulo-endothelial cells, its radioactivity, which might be poisonous, and because it might produce cancerous growth. Early in 1933 in a series of unpublished experiments with dogs, we found that purpura with fatal hemorrhage from the mucous membranes could be produced with a dose of 7 c.c. per kilogram. In such animals coagulation failed to occur. But these doses were relatively enormous. We have never seen hemorrhage or petechiæ in humans, although such have been reported (5).

Taft (6), using a Geiger counter, estimated the gamma radiation of 75 c.c. of thorium dioxide *in vitro* to be equivalent to that of 1.36 microgram of radium. Martland (7) called attention to the fact that as little as 2 micrograms of radium was found to be present in the entire body of patients suffering from severe radium poisoning. From this it would seem that the ordinary clinical dose borders on that which might become toxic. However, Rigler, Koucky, and Abraham (5) reported on its use in 175 cases, mentioning 22 patients who had had the drug one, two, or three years without showing any ill effects. Yater and Whitmore (8), with an experience of over 200 cases of its use, reported on 10 individuals who were living an average length of more than five years afterward without any signs of harmful effects. They also found no evidence of injury to the cells in the neighborhood of the deposited granules of thorium. While both of these groups of authors were careful enough to make mention of the well known fact that the ill effects of radioactive substances develop slowly and late, and that perhaps even five years was not a sufficient length of time to rule out potential danger, they nevertheless felt that thorium dioxide had a large field of usefulness. Reeves (9), who suggests the value of thorium dioxide in diagnosing abscess of the liver, speaks of cases living and well seven years after the drug was given. Stewart and Ghiselin (10) have reported two cases followed for over five years with no signs of harmful effects. These authors, however, with an experience of only 14 cases, consider the drug to have a limited value as a diagnostic aid, and to be potentially dangerous. We have patients who, having received the clinical doses three, four, and five years ago, are still alive and apparently not showing any harmful effects.

The intravenous injection of thorium dioxide might be objected to in cases in which suppuration in the liver is suspected, on the grounds that, in blocking the reticulo-endothelial system, immune reactions are interfered with and the patient's resistance to infection diminished. One clinical dose, however, would certainly not block the recticulo-endothelial system, if, indeed, total blocking under any conditions is possible (11, 12). In this connection the case report of a patient (Case 4) erroneously believed to have pylephlebitis just before thorium dioxide was used and who subsequently recovered despite serious intra-abdominal suppuration, complicated by acute mastoiditis, is interesting.

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It still remains for some one to report a case of an untoward effect in a human as a result of the use of thorium dioxide.

Because solitary abscess of the liver may be successfully treated by incision and drainage, it is frequently necessary in the treatment of the complication of appendicitis to decide whether pylephlebitis with single or multiple liver abscess is present. Since Waller's (13) report of a case following appendicitis, there have been many statistical contributions on the incidence of pylephlebitis. Unfortunately, in several studies cases of suppuration of the liver not of portal origin were indiscriminately included, and, therefore, such reports have not been considered here. In 1886, Fitz (14) found the complication at autopsy in 11 of 257 cases of appendicitis. In 1897, Armstrong's (15) 546 postmortem observations in appendicitis showed pylephlebitis in more than 5 per cent. In 1903, Gerster (16) reported 1,189 operative cases of acute appendicitis in which pylephlebitis was a complication nine times. This embraced his own experience from 1892 to 1901, at Mount Sinai Hospital in New York. In 1905, Munro (17) reported 15 undoubted cases. In the same year, Rendle Short (18) collected 1,000 cases of acute appendicitis with four instances of complicating pylephlebitis. In 1907, A. Moschcowitz and E. Moschcowitz (19) reported seven instances in 1,529 cases of appendicitis. In 1909, Giertz (20) published a record of four cases occurring in 533 cases of appendicitis. In 1913, Braun (21) found the condition eight times in 600 cases of appendicitis. Petren (22) found, during 1,340 autopsies after acute appendicitis, pylephlebitis in 5 per cent. Colp (23), reviewing all cases of appendicitis at Mount Sinai Hospital from 1916 to 1925, found that in 2,841 cases there were nine instances of complicating pylephlebitis.

In our last report (24), we found pylephlebitis in three instances out of 1,027 cases of acute appendicitis in a three and one-half year period ending Dec. 31, 1931. Since then we have had three additional cases. So that, in all, from July 1, 1928, to May 1, 1938, pylephlebitis occurred as a complication six times in our series of 4,561 cases of acute appendicitis.

The important signs and symptoms which are of diagnostic value are: pain and tenderness over the liver, tenderness in that region, chills and "spiking" temperature, jaundice, splenic enlargement and ascites.

A review of the case reports presented in the literature shows that but little emphasis is placed on pain as a symptom of pylephlebitis. Pain over the liver is not an invariable accompaniment of the lesion, and its inconstancy tends to make the diagnosis more difficult. When present, it is usually dull, is located in the right upper quadrant, and has extension to the shoulder blades. Tenderness is almost always present, although at times so slight as to be considered negligible. It may frequently be found directly over the portal vein. Local tenderness over the liver is always indicative of surface liver involvement with adhesion to the parietal peritoneum.

One of the most characteristic signs of the disease is the change in temperature. A rapid rise in temperature accompanied by chills occurring in the progress of an acute inflammation of any intra-abdominal organ, the veins from which drain into the portal system, must always be considered significant of entrance of septic material into the general circulation after it passes through the liver. If these events occur before operation, they help the physician in making a complete diagnosis; if they occur after operation, they point toward a serious complication. The variations in temperature may occupy a wide range, from slight fluctuations between 101 or 102° F. to marked variations from 98 to 104 or 106° F. The degree of change in temperature daily is no indication of the extent of disease (number of abscesses or the diffuseness of the lesion of the liver). The chill need not necessarily be daily and profuse perspiration is a frequent accompaniment of chill. Remission in both the chill and the rise in temperature may occur even

though the disease has progressed to quite a considerable degree. In Case 3 in this report there was an absence of chills for a period of 29 days.

Jaundice is almost always present at some time during the disease and is often one of the early signs of involvement of the liver. When it appears early in the disease (before the diagnosis of appendicitis, cholecystitis, etc., is made), it may be misleading, as it may draw attention away from a causative appendicitis and direct it to the biliary passages in a case in which involvement of the latter is only the terminal complication. In many of the reported instances the bilirubin content of the blood serum showed a progressive increase long before the jaundice could be noted clinically. The appearance of jaundice as a post-operative complication of appendicitis should arouse suspicion of the development of a complicating pylephlebitis. A slight icteric tint to the sclera may appear even before the first chill. The jaundice may be a transitory one, however, even though the case proceeds to a fatal termination (Case 3).

In the description of the pathologic processes found at autopsy in pylephlebitis, enlargement of the spleen is mentioned in many of the cases reported. In this connection it seems strange that little mention is made of splenic enlargement as a clinical sign of value in pointing toward the diagnosis. In all of our cases enlargement was noticed clinically, and it seems to us that it may be utilized as a valuable diagnostic sign. The presence of serous fluid in the peritoneal cavity in small amounts is expected because of the general peritoneal reaction to the inflammation of an organ in direct continuity to it. With complete obstruction of the portal vein, however, the development of ascites is far more likely to occur. It is usually not seen except terminally.

Of the other symptoms, anorexia, anemia, nausea, vomiting, lassitude, and emaciation, little need be said, because they are characteristic of any condition in which general systemic reaction to infection becomes manifest.

Examination of the blood for organisms is of little value in these cases, because in most instances the invading organism is *B. coli*, which rarely breaks into the blood and if it does it is quickly destroyed there.

In the typical case the diagnosis can be made by the shift of symptoms from the appendicular region to the hepatic region, following repeated chills and fever, in addition to the other symptoms and signs enumerated, all occurring in the absence of manifestations of extensive peritonitis. Munro's (17) dictum that, "the most important clue in making a diagnosis is the recognition of the causative appendicitis," while true, in most instances, is certainly not universally applicable. It must be remembered that the original focus may be in any abdominal organ, the venous drainage of which empties into the portal system.

Even though all of these signs and symptoms be present, doubt may still persist regarding both the presence of suppurative disease in the liver, its character and extent. Not infrequently suppuration, hidden in the abdominal cavity, either subphrenically or between the intestinal coils, gives a picture easily confused with pylephlebitis. In doubtful cases, the appearance of jaundice helps materially to swing the weight of evidence toward pylephlebitis, but does not necessarily clinch it.

Under such circumstances, it is possible to eliminate all doubt and speculation and make certain of the diagnosis by obtaining an x-ray of the liver after the intravenous injection of thorium dioxide. This drug is given in doses of 25 c.c., on three successive days, and is picked up by the phagocytic cells of the reticulo-endothelial system and its radiopacity gives, in normal individuals, an x-ray shadow of uniform density. In the case of an abscess of the liver the density no longer is uniform, the abscess cavity being distinctly outlined as an area of lesser density. If multiple abscesses exist, the liver shadow becomes mottled.

By this technic it is easily established (1) whether or not a patient has suppura-

tion in the liver, (2) whether the liver suppuration exists in the form of a single abscess or as multiple abscesses, and (3) if the patient deserves exploration, what route is the most direct line of approach.

The following case histories are typical examples of the difficulties encountered clinically. They demonstrate the importance of clinical signs in making the diagnosis and the value of thorium dioxide not only as a diagnostic aid in questionable cases, but also as the determining factor in deciding upon abdominal or liver exploration. The fourth case reported in this group is a striking example of how thorium dioxide can eliminate pylephlebitis from consideration in the differential diagnosis, and, therefore, help direct attention to the real site of suppuration.

Case 1 (No. 22,276). A white woman, 36 years of age, had an appendectomy for acute appendicitis three days after the onset of severe lower abdominal cramps, vomiting, and fever. The appendix was found to be gangrenous and perforated, walled off by omentum and small intestines. A cigarette drain was placed in the pelvis. Post-operative course was stormy at first, but, when she was discharged on the twenty-fifth day, the wound was healed, the temperature was normal, and she was apparently cured.

She returned to the hospital fifteen days later complaining of fever, chills, and malaise for the previous five days. The physical examination was negative until the third day after her admission when the spleen was felt below the costal margin.

The temperature fluctuated between 107.8 and 104°, with occasional chills. The leukocyte count was 15,000 on admission and remained between 22,000 and 42,000. The x-ray examination of the chest was negative. There was no elevation of the diaphragm.

On the twenty-fourth day of her stay in the hospital, an icteric tinge was noticed on the sclera. The icteric index was 26 and the van den Bergh test positive. At this time differential diagnosis between hidden suppuration in the abdomen and pylephlebitis was difficult to establish and several consultants advised exploratory laparotomy. However, an x-ray of the abdomen after the intravenous injection of thorium dioxide showed a mottled liver shadow characteristic of multiple abscesses or multiple metastases in the liver. The liver and spleen were enlarged. On this basis the diagnosis of pylephlebitis was made and operation was considered inadvisable. The jaundice increased. The patient continued slowly downhill until her death, 55 days after admission.

Case 2 (No. 32,433). A white male, 44 years of age, had had intermittent cramplike pain in the right flank for nine days before admission. The temperature had been between 103 and 105° and he had had several chills.

He appeared acutely ill, but his abdomen was soft and not tender. The liver edge, which was felt two fingers below the umbilicus, was not tender, but there was slight shock tenderness over the right lower ribs anteriorly and a strongly positive right Murphy sign. The physical examination was otherwise negative.

The temperature ranged between 102.4 and 105.6°, with several chills. The blood cultures were negative until the sixth day, when streptococci were recovered.

The cystoscopy and pyelography were negative. The leukocyte count was 17,600 with 86 per cent polynuclears, 12 per cent lymphocytes, and 2 per cent myelocytes. The icteric index was 6. The van den Bergh test, which was weakly positive at first, became increasingly strong.

The x-ray examination of the abdomen after the intravenous injection of thorium dioxide showed a large liver with a large area of diminished density about three inches above the lower border (Fig. 1).

The fluoroscopic examination of the chest showed slight elevation of the right diaphragm, but mobility was normal.

On the eleventh day after admission, as soon as the x-ray diagnosis of solitary liver abscess was made, exploratory laparotomy was done under spinal anesthesia through an upper right rectus incision.

There was a large abscess on the lower anterior surface of the liver. The appendix was found to be buried in an abscess and completely walled off. The portal vein was thickened, thrombosed, and studded with petechial hemorrhages.

The surface of the liver was walled off from the abdominal cavity by three gauze strips whose ends extended through the upper abdominal wound which was closed with through-to-through sutures. The appendiceal abscess was then opened through a lower right rectus incision and the appendix removed. A cigarette drain was placed in the abscess cavity and the wound closed in layers. Two days later, the top of the liver abscess was removed with the endotherm knife. Eight hundred c.c. of bile-stained pus were aspirated, a rubber tube was inserted, and the cavity packed with gauze.

The patient died two days later in pulmonary edema, in spite of treatment for a gradually failing circulation.

Case 3. (No. 36,415). A 24-year-old white male who had been ill for six days with pain in the right lower quadrant was operated on for appendiceal abscess. A perforated gangrenous appendix was found in an abscess cavity walled off by omentum, cecum, and ileum. The appendix was removed and a gauze drain inserted.

The post-operative course was stormy. By the eighth day the patient's temperature had come down from 105 to 99.8°. The next day his temperature rose to 101° and he had his first chill. On the following day when the skin sutures were removed, a knuckle of intestine was found in the wound. It was replaced and the wound packed.

Following a small perforation of the bowel with development of a spontaneous fecal fistula, the abdominal distention was relieved and the patient was able to take fluids by mouth. The temperature remained elevated, however, and on the twenty-third day after operation, the patient had another chill with a temperature of 104°, and two days later a hard mass was felt on rectal examination.

He continued to have chills at irregular intervals; his temperature went as high as 107°. The wound continued to drain feces and pus.

His condition was essentially unchanged until the thirty-first day post-operatively when a weak, indirect van den Bergh reaction was obtained and pylephlebitis was suspected. Repeated blood cultures were negative.

About ten days later, his sclera were

Fig. 1. There is a large, almost circular area of diminished density in the lower portion of the right lobe.

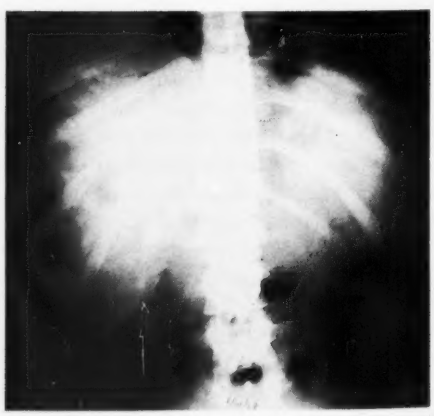

Fig. 2. There are many areas of diminished density scattered throughout the liver, giving it a mottled appearance.

faintly icteric. At this time the icteric index was 19 and the van den Bergh reactions, direct and indirect, were positive. This was considered to be confirmation of the diagnosis of pylephlebitis. As it was hoped that the patient might have a solitary liver abscess which could be drained successfully, x-rays of the abdomen were taken after the intravenous injection of thorium dioxide. The mottled appearance of the liver shadow in these films, while confirming the diagnosis of pylephlebitis, indicated the presence of multiple abscesses throughout the liver which would not be amenable to surgical treatment (Fig. 2).

Following a blood transfusion on the tenth day, the patient's condition improved markedly and the jaundice disappeared, but fever and chills persisted. Then, on the fifty-fourth day the patient became irrational. His temperature fell and remained at normal levels till the seventy-ninth day, but he was apathetic and almost stuporous. Following a severe chill, the patient became comatose and died on the eighty-fifth day after appendectomy.

The postmortem examination revealed a liver studded with abscesses of all sizes.

Case 4. (No. 36,004). A white male, 44 years of age, had a gangrenous appendix removed from an abscess in right lumbar gutter nine days after the onset of abdominal cramps, fever, and nausea.

Post-operatively his temperature had remained elevated and on the third day he had developed signs of a bronchopneumonia of the base of the left lung, which lasted about five days.

On the fifth day after operation he had his first chill after the removal of a gauze drain from the abdomen. On the eighth day he had two chills and went into collapse from which he recovered after the usual measures. From that time on he continued to have chills at irregular intervals (about 40 within the next month) with temperature as high as 107.4°.

On the seventeenth day he was given thorotrast intravenously. The x-rays of the abdomen were taken to determine whether or not there was abscess formation in the liver. The liver shadow was normal in appearance.

By the twenty-fifth day there were definite signs of an abscess in the right loin and this was incised and a cigarette drain inserted.

The drainage from both wounds continued profusely, but the patient's temperature continued to spike as before and his chills continued.

The blood cultures were negative; repeated x-rays of the liver and spleen were negative and there was only transient improvement after a transfusion.

On the thirty-ninth day the patient began to complain of pain in the right ear from which there was a spontaneous purulent discharge five days later. Examination revealed slight sagging of the posterior canal wall and tenderness over the mastoid. X-rays revealed only slight shading over the right mastoid; the cell wall structure was intact.

X-ray examinations of the liver and spleen remained negative; those of the mastoids were unchanged. The abdominal wounds drained profusely. There was a purulent discharge from the right ear. The temperature was somewhat lower and chills less frequent.

On the sixty-second day after appendectomy, a mastoidectomy was performed under spinal anesthesia. The mastoid cells were found to be filled with pus and granulations and the mastoid tip was completely destroyed. The mastoid cells were exenterated. The dura was exposed during the course of the operation. The sinus plate was opened and the sinus was normal in appearance.

The abdominal wound was probed and revised while the patient was under anesthesia but no pockets were found.

From this time on, the patient's temperature fell gradually and there were no more chills.

On the ninety-second day after appendectomy, the temperature was normal and the patient was allowed out of bed,

though the abdominal wound was still draining profusely.

A week later, 99 days after appendectomy, the patient was discharged with the abdominal and mastoid wounds completely healed and a small granulating surface in the right loin. The temperature was normal.

Though it is certainly not definitely established that thorotrast is entirely harmless, it would appear that since it has great value as a differential diagnostic aid in cases in which liver suppuration is suspected or feared, and since such aid may mean the difference between life and death, inferences regarding the potential danger of the drug may be brushed aside and left to the future for final decision.

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# THE STATUS OF SOME OF THE TECHNICAL FACTORS IN CHOLECYSTOGRAPHY[1]

*By* MAURICE FELDMAN, M.D., *Baltimore, Maryland*

CHOLECYSTOGRAPHY is an important roentgen method of examination of the gall bladder. Since the advent of this test, our knowledge regarding the various technical factors in oral cholecystography has been tremendously increased. In recent years numerous factors influencing the cholecystographic test have come to light, concerning which there are obviously many opinions. This communication is, therefore, presented to offer suggestions for the furtherance of a better understanding regarding some of the technical factors in cholecystography.

Since Graham's first original publication on this subject, there have been numerous attempts to simplify the technical factors in oral cholecystography. Changes have been advocated in order to enable the roentgenologist to obtain uniform and satisfactory gall-bladder shadows and to eliminate all unnecessary steps in the routine procedure. For many years we have stressed the importance of simplifying the cholecystographic test, and have emphasized the accuracy of our results obtained by this less complex method of examination. In order to secure better results many roentgenologists have utilized numerous modifications in the cholecystographic technic, many of which have been impractical, excessive, and of no real diagnostic value. The only thing which can be said about some of the more elaborate methods is that they have been made to create a favorable impression on the patient.

One is astounded by the varieties of technic utilized in cholecystography. A collection of twenty printed instruction lists from different parts of the country reveals a striking lack of uniformity. One of these lists has as many as ten different directions for the patient to perform at home. Such a long list is not only unnecessary, but often exceedingly confusing. Instructions to the patient should be clear and concise and as few as possible. It has been our experience that the simpler the directions, the less confusing they are to the patient. In our technic we not only insist on giving few instructions to the patient, but allow him to do as little of the test as possible. The roentgenologist, nurse, or technician should administer rather than prescribe the dye.

There are a number of reliable tetraiodophenolphthalein preparations on the market, all of which are distributed under various trade names. Basically, they are supposed to contain the same dye, sodium tetraiodophenolphthalein U.S.P. Thus it makes little difference which preparation is used. However, the amount of dye in the various marketed preparations differs. It cannot be too strongly emphasized that it is not only the preparation itself, but the amount of dye it contains that is of importance, since it is the dosage which is highly essential in obtaining uniform gall-bladder shadows. The dye is distributed in containers of 3.5, 4, 4.5, 5, 6.5, and 7 grams of tetraiodophenolphthalein, and also a double-dose container which varies from 6 to 7 grams of the dye. There is no doubt that there is a lack of uniformity in the dosage among the various tetraiodophenolphthalein preparations, which tends to cause some confusion among roentgenologists as to which preparation is best to use. Many distributors of the dye have failed to keep abreast with the more progressive work in this field. Notwithstanding the lack of standardization in the dosage of the dye, there has been a steadily increasing tendency lately to augment the amount of tetraiodophenolphthalein supplied by the distributors. This change has been brought about by a few of the more progressive roentgenologists who de-

[1] Accepted for publication in October, 1939.

manded larger doses of the dye. At first the dye was specially packed to satisfy these demands, and later some of the distributors augmented the dosage as the demand increased. Unfortunately, however, the changes in dosage have not been uniformly carried out by all of the drug concerns.

It is interesting to note that some of the distributors of the dye do not have the amount of tetraiodophenolphthalein printed on the label of the container. Roentgenologists should insist on knowing the amount of dye they are administering. It is supposed that the distributors recognize the lack of a standardized uniform dosage and, therefore, in some instances, instead of indicating the amount of dye on the container, the preparations are marketed as "regular" or "heavy," or *A* or *B*. As a consequence, the actual dosage of dye administered is not always known to the roentgenologists using these preparations.

During the many years of experience with oral cholecystography, it has been observed that in thin patients the administration of dye according to their body weight has sometimes yielded a poor gall-bladder shadow or even a non-filling of the gall bladder. On this account, a minimum dosage of 6 grams of tetraiodophenolphthalein has been advocated in all cases. However, in individuals weighing above 160 pounds it is advisable to administer 9 or 10 grams, and in those weighing 200 pounds or over, 13 grams of dye may be administered in a single dose. It must also be pointed out that in certain conditions the weight of the patient must not be considered; for example, in some cases of peptic ulcer with high gastric acidity an extra large dosage of dye must be given in order to obtain satisfactory gall-bladder shadows. This also holds true in cases of pregnancy and some other conditions.

The best time to administer the dye for an 18-hour gall-bladder examination is between 1 and 2 P.M. The patient, having had a usual breakfast, is instructed to eat a mid-day lunch consisting of a cup of tea and a slice or two of toast with jelly or jam. The dye is administered from one to two hours after this light lunch. The only other directions given to the patient are that he abstain from food and medicines of all kinds. Water and orange juice in any amount may be permitted. We do not advise giving paregoric routinely, since it is not only unnecessary, but at times slows up intestinal motility to a marked degree, which is undesirable. However, paregoric is administered in cases of diarrhea or to those individuals who have a marked tendency to loose bowels. When paregoric is indicated it is given immediately following the administration of the dye. The patient is instructed to take a cleansing enema on arising the next morning and return for the x-ray examination at 8 A.M.

The aforementioned single-dose technic avoids many unnecessary instructions. It utilizes the optimum load of dye absorption, by bringing to the gall bladder the maximum amount of dye at one time, thus enabling the roentgenologist to obtain uniform dense gall-bladder shadows, the test of which are obtained from 18 to 20 hours following the administration of the dye. Giving the dye in the evening and baking the roentgenograms the next morning between the twelfth and fifteenth hours is not generally advisable, since with this technic it is often necessary to take another series of films at a later hour. This procedure seems to offer no advantage.

The divided-dose technic gives satisfactory cholecystographic results, but does not seem to be superior in any way to the single-dose method. The utility of the single-dose method has been fully demonstrated in a previous communication. The principle of the double-dose method is to allow for a greater period of optimal intestinal absorption of the dye. It must be emphasized that in giving the single dose, the total amount of dye administered must be equal to that of the divided dose. It has been our experience that many roentgenologists employing the

single-dose method persist in administering 4 or 4.5 grams of dye as a full dose in all cases, regardless of weight or other conditions. Their results are, therefore, not uniform, often misleading and unsatisfactory.

The technical factors involved in obtaining satisfactory gall-bladder shadows are often difficult. The positioning of the patient is most important and a rapid Bucky technic is essential. The elimination of shadows outside the gall bladder frequently requires a great amount of effort and the taking of many films in different positions. Many roentgenologic laboratories routinely make from two to four films of the gall bladder. An inadequate number of films will, in many instances, require many retakes. It cannot be too strongly emphasized that each case should be individualized. One should remember, too, that a well filled vesicle does not necessarily eliminate a pathologic gall bladder, nor does it eliminate the presence of stones, in all instances. Small or minute, soft or gravel stones may be present and are often overlooked with the ordinary routine technic. To avoid these pitfalls, one or two films made in different special positions often aid in demonstrating abnormal signs which are not generally seen in roentgenograms of the gall bladder made in the routine positions. In cases giving a clinical history of gallstones, even though the cholecystographic test reveals no stones, some attempt should be made to examine the patient further in the upright posture. At times the contracted gall-bladder film, made following a fat meal, may reveal minute stones, for under such circumstances the small stones are clustered together, making them more readily visible in a group than when separated.

An important procedure in every instance is the determination of the contractility of the gall bladder following the response to a fat meal. This is a method of measuring one of the functions of the gall bladder. There has been a tendency to eliminate this procedure, since some believe that it gives insufficient information to warrant the extra examination as a routine measure. In our experience the fat meal roentgenogram has been most helpful and frequently very informative. A fat meal, consisting of a milkshake of two eggs and a glass of milk, is given to the patient immediately following the 18-hour examination of the gall bladder and a roentgenogram is made 30 minutes later. After this period the normal gall bladder will show a maximum initial contraction.

## CONCLUSIONS

1. Emphasis is placed upon simplifying the cholecystographic test.

2. Some confusion exists among roentgenologists regarding a uniform set of instructions to be given to the patient, but we advocate as few directions as possible.

3. Administration of all dyes and drugs pertaining to the gall-bladder test should be administered in the roentgen department.

4. There seems to be a difference of opinion as to the best preparation of the dye to use for the cholecystographic test. It is pointed out that basically the dye is similar in all of the preparations, the difference being in the flavoring or in the amount of tetraiodophenolphthalein.

5. There exists a definite universal lack of individualization in carrying out the test.

6. There is a lack of uniformity as to the best time for making the roentgen examination. The uselessness of the 12- and 15-hour roentgen studies as a routine measure is emphasized, this procedure often necessitating a second series of films at a later hour.

7. The difference between the single- and double-dose methods of administering the dye is one of dosage. In the double-dose method, from 6 to 7 grams of dye is administered, whereas in the single-dose procedure less than this amount of dye is often used. With similar dosages of dye, equally satisfactory and uniform gall-bladder shadows may be obtained by either the single- or double-dose method.

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# CASE REPORTS AND NEW DEVICES

## FILM FILING—THE MODERN WAY[1]

*By* AARON J. SIEGEL, Supervisor, X-ray Technicians, Department of Health, *New York City*

The storage of x-ray films has always been a problem in the average x-ray laboratory because of the cost of files and the lack of space to preserve the films adequately. The increasing use of x-ray facilities, and the accepted practice of storing films for from two to five years, or longer, has served to make the problem more acute.

The Bureau of Tuberculosis of the New York City Department of Health operates 22 chest clinics, and in the past seven years over one-half million roentgenograms have been taken employing both celluloid and paper films. Our filing problem is, therefore, obvious.

At first, three-drawer x-ray film files, which hold 2,000 films in envelopes, were used. These had several disadvantages, the most important being that it was impossible to provide space for the additional files required yearly in each clinic. In fact, in many instances it was necessary to discard old films to make room for current work.

In 1935, the Department started using steel shelving instead of three-drawer files. A diagram of the shelving is shown in Figure 1.

When filed, the envelopes protrude 1 inch over the edge of the shelf, making it easy to find films whether filed numerically or alphabetically. The shelving is built to the full height of the room and a wooden ladder on a rail is provided so that the top shelves may be used.

With an equal amount of floor space, at least twice as many films can be filed in shelves as in drawers since the entire wall space is filled with shelves while only the lower part of the wall is used for files. The price of shelving is such that the cost of filing films in this manner is less than half that of filing an equal amount in drawers. At present, shelving is being installed in all our new clinics, and is being used to replace the three-drawer files in the others. Since all x-ray films are now of the safety type, the films filed in this way do not constitute a fire hazard.

However, even the use of shelves did not prove adequate to permit the clinics to accommodate the films on both current and inactive patients for over two years; hence, the Central Record File was established for storing the inactive films and records.

This unit is located in the Bureau headquarters. Once a year the clinics send films and records on inactive patients to this division and retain only the current work in their files. Thus, in 1937, films and records on patients who had not attended a clinic since December, 1934, were forwarded. Abstracts were made of the clinic records: these and the films were filed so as to be readily available when required. The abstracts are retained indefinitely as are the films showing pathologic changes; those films read as negative are discarded five years after the patient becomes inactive and are sold for salvage.

However, even the discarding of negative films did not release sufficient space to care for the number being sent in, and the space in the Central Record File was soon exhausted.

Destroying films also has one distinct disadvantage in that, at times, x-rays of vital importance are discarded. Frequently patients return to the clinic after their films have been destroyed; although the x-ray has been read as negative and an abstract is available, the original film or copy is desirable for purposes of comparison. It was evident, therefore, that another method of keeping films was necessary; one which would permit the retention of all films or facsimiles indefinitely.

Recently, at our suggestion and under our direction, a method for reproducing large numbers of paper and celluloid films rapidly has been developed. This is now commercially available through several companies.

The apparatus used is of the type designed for reproducing all types of material, including newspapers, on microfilm. The camera is constructed to hold a 100-foot roll of 35-mm. film. It is mounted on a column approximately 10 feet high, which is calibrated with the lens so that adjustments for various sizes of film may be made quickly. The exposure is made by means of a foot treadle. The celluloid film is placed on the machine over an illuminator having a variable intensity control so that the operator may vary the degree of illumination according to the density of the film. In the case of paper film, reflected light is used.

The design is such that the operation is practically automatic, and a trained operator can readily make over 3,000 reproductions per day.

Safety film, having an exceptionally fine grained emulsion designed to react most favorably to the densities found on roentgenograms, is used. The detail obtained with this is excellent. Obviously, it is impossible to produce detail not already in the original roentgenogram but the x-ray film can be reproduced

[1] Read before Long Island Radiological Society, January, 1939.

accurately. Since all of our material consists of chest x-rays, the experimental work was along those lines. However, the few reproductions which were made of roentgenograms of the spine, pelvis, and cervical vertebræ, seem to indicate that any roentgenogram can be effectively copied (Figs. 2 and 3).

The first procedure is to make a "master" copy; that is, a 35 mm. positive of the x-ray negative. Black on the x-ray is white on the "master"copy, and *vice versa*.

This master copy can be used in an enlarger to make reproductions on celluloid, paper, translite, or lantern slides. The print from the master copy, which is also made on a 35-mm. film, may be used for reviewing as it projects an image identical with the original x-ray. A projector suitable for reviewing the film in clinics or offices is available. This plugs into an ordinary receptacle and may be used in daylight; a darkened room is not required.

Either the master copy or the print can be

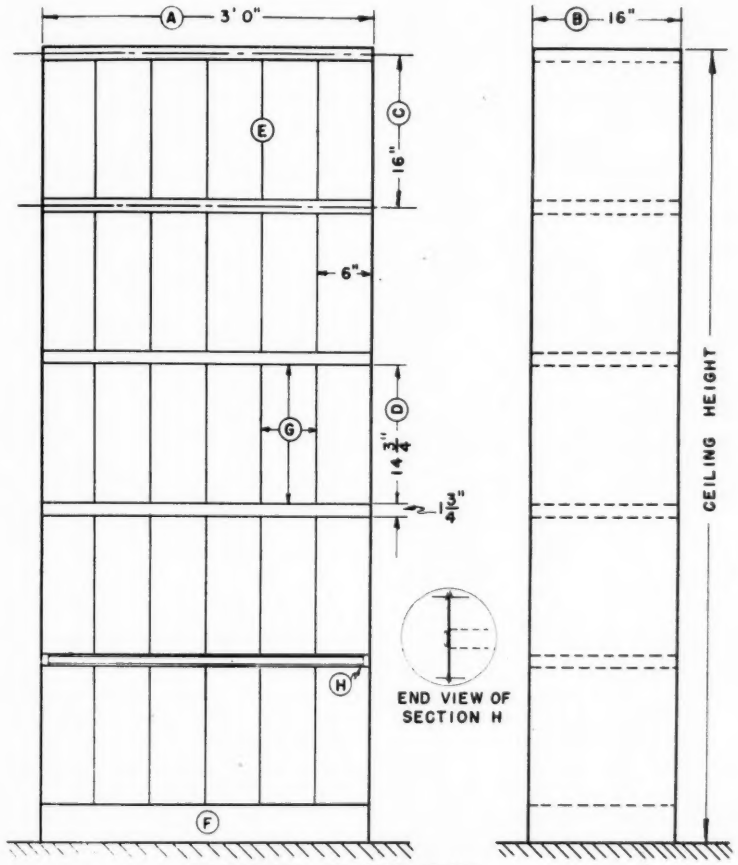


DIAGRAM OF SHELVING

(A) UNITS 3 FEET WIDE
(B) 16" DEPTH
(C) 16" SHELVES ON CENTERS
(D) 14 3/4" FREE SPACE BETWEEN SHELVES
(E) STEEL DIVIDERS
(F) FACCIA MAY VARY FROM 1" TO 6"
(G) COMPARTMENT 6"X 16"X 4 3/4"
(H) INDEX SLOT

**FIGURE 1**

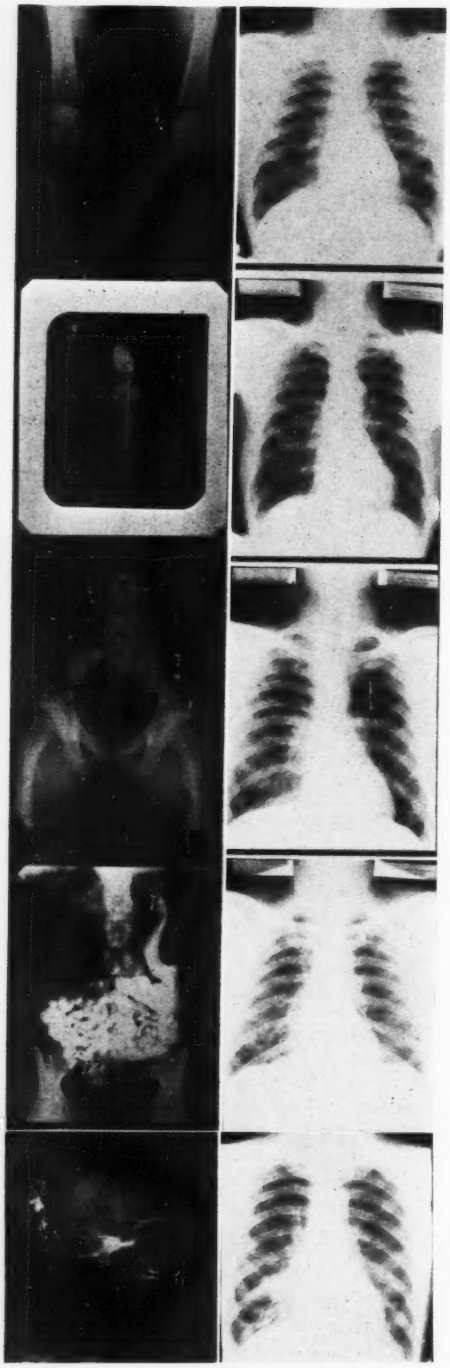

Fig. 2. Photographic reproductions of roentgenograms taken on celluloid film.

Fig. 3. Photographic reproductions of chest roentgenograms taken on paper film.

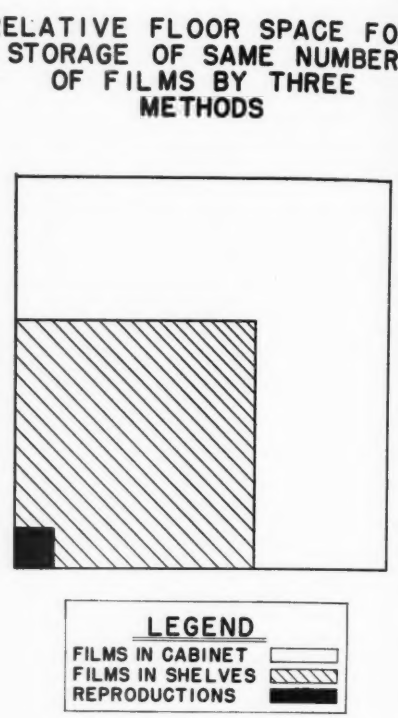
RELATIVE FLOOR SPACE FOR STORAGE OF SAME NUMBER OF FILMS BY THREE METHODS
LEGEND
FILMS IN CABINET
FILMS IN SHELVES
REPRODUCTIONS

Fig. 4.

used in a projector during lectures, the only precaution necessary being the use of a machine which provides protection for the film against excessive heat.

A 100-foot roll of film, sufficient to make photographs of 800 14 × 17 x-rays, occupies 6 cubic in. of space. It is, therefore, possible to store over a quarter of a million reproductions in the same amount of space occupied by one three-drawer filing cabinet which holds 2,000 films, or by shelves holding 5,000 films (Fig. 4). The apparatus is large, occupying 35 sq. ft. of floor space and weighing 650 pounds. A trained operator is required to obtain the most efficient results. Consequently, the work at present is done on a service basis; that is, the company does the work at their plant, or installs the machine where desired and provides the operator. This places the responsibility for furnishing a good product on the company, which is in a better position to provide facilities and trained personnel than private organizations. However, it is anticipated that in the near future a smaller model of this machine will be available, which will be suitable for permanent installation in hospitals and clinics.

The cost per reproduction in large quantities

is less than three cents each, which includes both the master copy and the print.

The saving in the cost of files is at least one and one-half cents per film, which, when added to the price received for salvage, brings the actual cost per reproduction to about one cent.

The most important advantage of this method is that facsimiles of every x-ray can be retained indefinitely. The National Bureau of Standards, Washington, D. C., states that the film will last as long or longer than paper of maximum purity. Similar films of records passed through a recent flood undamaged. Reproductions of checks and other documents made by this method have been accepted by the Courts.

Sutherland (1) suggests a central film library in Washington, with eventual branches throughout the country where reproductions of film studies could be filed: microfilm is the ideal method for carrying out such a project.

The idea of photographing x-ray films is not new; nearly every one in the field has sought a method by which reproductions which were true copies could be made rapidly at a low cost. This method is the result of such experiments; a method which shows such remarkable possibilities that x-ray laboratories having a filing problem cannot afford to ignore its potentialities.

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## ROENTGENOLOGIC OBSERVATION OF THE FORMATION OF A CALCIUM CARBONATE GALLSTONE[1]

*By* JULIUS BÁRON, M.D., *Chicago*

Calcium carbonate gallstones are comparatively rare. In a series of cases reported by Phemister, Rewbridge, Rudisill, Day, and Hastings this condition was diagnosed by x-ray examination. The writer has also described a case similar to those observed by Phemister and his co-workers. On the basis of their operative findings and animal experiments, these authors believe that obstruction of the cystic duct and low grade chronic inflammation of the gall bladder are the conditions under which calcium carbonate gallstones are formed. In the first stage of this process, sandy particles of calcium carbonate are excreted into the gall bladder. In this stage the gall bladder contains a thick liquid which was designated as "lime water bile" by Volckmann. Later the content of the gall bladder is condensed, forming a thick paste of calcium carbonate. Finally, a hard stone is formed. Recently, the author observed a case in which the x-ray films, taken within 19 days, showed the first and the last stage of the formation of a calcium carbonate gallstone.

E. J., male, aged 59 years, had had several rather mild attacks of pain in the right upper quadrant, during a period of two years. His attending physician asked for an x-ray examination of the stomach. Before giving the patient the opaque meal, fluoroscopy of the abdomen was done. In the right lower quadrant, at the height of the crista ilei, a semilunar-shaped radiopaque shadow was sighted, which was the size of a cherry. Frontal radioscopy revealed that the shadow was to the fore of the abdomen. The lower contour of the shadow was convex downward; the upper contour was a straight line which remained straight when the patient was inclined laterally. In short, it behaved as a surface of fluid. When the patient was observed through the fluoroscope in the horizontal posture, the shadow was invisible. However, in the film made in this position, alongside the lower contour of the liver, there was a shadow of weak opacity which had the shape and size of the gall bladder. The intensive semilunar shadow became visible again at once when the patient was brought into the upright position. Further examination showed that the semilunar shadow had no connection with the shadows of the stomach or of the intestines. These latter showed nothing abnormal.

A cholecystography had now to be performed, but the patient came for this examination only 19 days later. Before giving him the dye, we made another fluoroscopic examination. The semilunar shadow was no longer visible. Instead of this, a radiopaque elliptic shadow the size of an almond was found in the same place. This shadow had a constant shape and could be seen equally in the upright and in the horizontal postures of the patient. Peroral cholecystography showed non-visualization of the gall bladder. The patient was not operated upon.

So far as the author knows, the first stage of the formation of a calcium carbonate gallstone has hitherto been seen only by the surgeon. At least, I have not found any mention of a semilunar shadow like the one described above. Perhaps this stage does not last long. But the main cause of its being hitherto roentgenologically unnoticed seems to be the fact that fluoroscopic examination of the gall bladder in the upright position is generally omitted, and x-ray films only in the horizontal position made. In this position, the semilunar shadow

[1] Accepted for publication in February, 1939.

Fig. 1.

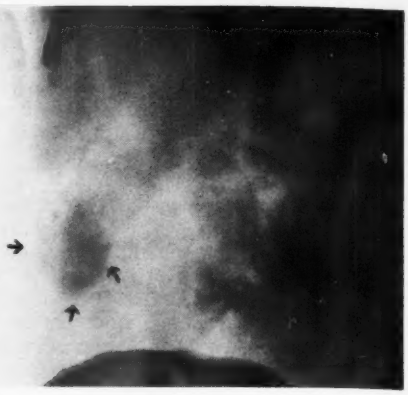

Fig. 2.

Fig. 1. Examination (Nov. 28, 1938), in upright position.
Fig. 2. Examination (Nov. 28, 1938) patient in horizontal position.

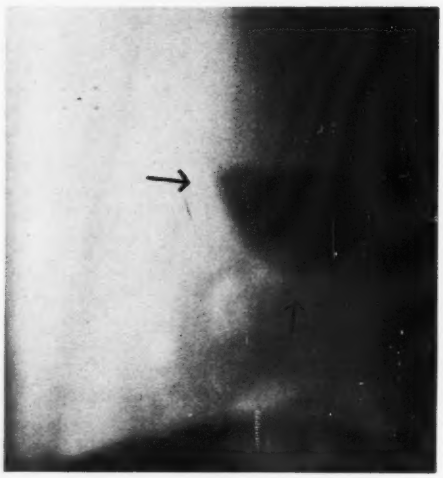

Fig. 3.

Fig. 4.

Fig. 3. Examination (Nov. 28, 1938), in upright position.
Fig. 4. Examination (Dec. 17, 1938), in horizontal position.

cannot be visualized, the direction of the rays being perpendicular to the surface of the sedimented calcium carbonate layer. In our case we found in the film made in the horizontal position, a weak shadow of the gall bladder. Similar films of the gall bladder are published in the book of Teschendorf. In his illustrations weak gall-bladder shadows are visible, though the patients did not receive radiopaque substance. In both cases there was a carcinoma of the gall bladder with obstruction of the common bile duct. It seems possible that the visibility of the gall bladder in these cases was caused also by calcium carbonate deposit in the gall bladder. Perhaps a film taken in the upright position would have revealed a semilunar shadow similar to the one found in our case.

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## COLLECTION OF FEES

For a number of years there has been considerable discussion concerning the best methods for collection of fees for radiological services performed in the hospital. Frequent reference to this subject has been included in the literature published by the American College of Radiology and the Inter-Society Committee for Radiology.

It has been argued that collection of radiological fees on a billhead bearing the name of the radiologist created a favorable impression upon patients and referring physicians alike. Too often, it has been said, a patient is discharged from a hospital, paying a bill at the cashier's office which included a charge for x-ray services, without ever realizing that he has received a consultative service from a physician-specialist in radiology. The patient is apt to tell his friends that "The hospital made some x-ray pictures and Doctor Jones [his attending physician], after studying them, decided I was going to be all right." Indeed, there are instances in which a patient receives roentgen therapy and is actually cured of a cancer, without knowing the identity of the radiologist who effected that cure.

Cognizant of these occasional situations, the Manual of Desirable Standards for Hospital Radiological Departments of the American College of Radiology expressly recommends that radiologists practising in hospitals render bills and themselves collect for their professional services to patients. That these recommendations have not been entirely ignored is indicated by the fact that to-day more than 20 per cent of all radiologists collect in the radiological department for services to hospital patients or render separate bills on their own billhead which are collected by the hospital cashier. In a recent study by the Inter-Society Committee for Radiology, it was revealed that this is the practice in 197 hospitals.

Recently, the Board of Trustees of the American College of Surgeons, considering the tendency for hospitals to assume the rôle of a middleman in the relationship between doctors and their patients, adopted a set of principles pertaining to the financial relations in the professional care of patients in the hospital. The following provisions in that set of principles, now incorporated in the "Manual of Hospital Standardization" of the American College of Surgeons, are of particular interest to radiologists:

"1. Each doctor who participates in the care of a patient is entitled to compensation from the patient commensurate with the services rendered.

"2. Whenever practicable and possible the attending doctor should acquaint his patient with his financial responsibility to those concerned with his care.

"3. Each doctor concerned in the care of a patient should give or send directly to the patient a detailed statement showing charges for professional services rendered.

"4. Combined statements should be avoided, as they may constitute a subterfuge for fee-splitting.

"5. Each doctor who participates in the care of the patient should send a personal receipt directly to the patient for all moneys received from the patient or other legitimate or authorized source.

"6. Insofar as possible, a third person should not enter into the financial relations between doctor and patient, and to this end hospitals should be discouraged from determining or collecting fees for doctors.

"7. An exception to the foregoing principles must, of necessity, be made when there is a formally organized clinic or legal partnership which, in effect, may be regarded as an individual and which acts in that capacity. This principle should apply also when the clinic and hospital are combined and under the same ownership."

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## SELECTIVE SERVICE EXAMINATIONS

The following bulletins were sent by the American College of Radiology to its list of State representatives and the secretaries of regional radiological societies last month. They are published herewith for the information of all radiologists.

*Selective Service Examinations (Oct. 29, 1940).*—This bulletin is to advise you concerning procedures adopted for the examination for physical qualifications of registrants under the Se-

lective Service Act. Some details in this procedure have not yet been completed and, as a consequence, the information contained herein may be supplemented or revised in future bulletins. Vincent W. Archer, M.D., Chairman of the Board of Chancellors, has authorized this office to disseminate all pertinent information of special interest to radiologists in connection with Selective Service as subsequent regulations are adopted.

The basic responsibility of determination as to physical qualifications of registrants will rest on local draft boards in some 6,500 communities. Local boards under Selective Service Regulations have original jurisdiction with respect to physical qualifications of registrants, subject to appeal. Each local board will have one or more examining physicians who will examine all registrants sent to them by the local board. Standards of physical examinations will be furnished them. It is estimated that there will be about 90 men per local board requiring physical examination. Examining physicians will be appointed by the President upon recommendation of the Governors of the respective States. They will serve without pay.

Provision has been made to furnish the supplies required in physical examinations and to pay on a cost basis for those procedures necessary for the determination of a draftee's physical fitness, such as laboratory or x-ray examinations. A subcommittee of the Committee on Medical Preparedness has been appointed to establish a schedule of charges on the basis of which pathologists, radiologists, and other special examiners will be reimbursed for the costs incurred in making examinations referred to them. This schedule has not yet been completed.

As provided in the Selective Service Act (Section VII-146), Medical Advisory Boards "shall be appointed by the Governor of each State to assist local boards in determining the physical qualifications of registrants. The Board shall, if practicable, consist of internists; eye, ear, nose, and throat specialists; orthopedists; surgeons; psychiatrists; clinical pathologists; radiographers, and dentists. In the event that a Medical Advisory Board cannot be made available to a local board, the Governor shall appoint individual specialists who shall act as a Medical Advisory Board."

The chairman of each Medical Advisory Board shall authorize such special examinations and laboratory tests as he may deem necessary and shall cause to be forwarded to the State Procurement officer for payment the bill for such examinations (Section VII-529).

It is unfortunate that the term "radiographers" was used in the Act. However, it is obvious that the officials of Selective Service contemplated the employment of licensed radiologists in private offices and hospitals to perform examinations when such are indicated.

Physicians appointed to the Medical Advisory Boards are being asked to sign a waiver of "any right to pay or compensation in any form whatsoever for services" (Form DSS-257). In the case of radiologists appointed to the Medical Advisory Boards, this conflicts with the agreement to defray the costs of x-ray examinations. We suggest, therefore, that radiologists appointed to the Medical Advisory Board delete the sentence quoted above and substitute therefor something similar to the following:

> "I hereby expressly waive any right to pay or compensation in any form whatsoever for services rendered as a consulting radiologist in matters of special opinion or advice which may arise in the work of this Board; except that, for any roentgen examinations requested of me by this Board or local draft boards, I shall expect reimbursement on a reasonable basis for the actual expenses incurred in performing such roentgen examinations, and the right to compensation for those costs I hereby expressly retain."

Roentgen examinations of the chest will be ordered by local examining physicians only as required in order to determine definitely whether a draftee is physically fit and will not be required for all draftees.

After having been selected for service by the local draft boards, and following the adjudication of any appeal, a registrant is referred to an "Induction Board" in his Corps Area. He is now in the Army. The Induction Board will order a complete physical examination which will include routine chest films to be made with special x-ray units, approximately 100 of which have been ordered by the Army. Civilian physicians serving on these Induction Boards will be paid on a *per diem* basis.

It is our request that State representatives of the Inter-Society Committee and secretaries of regional societies receiving this bulletin assume the responsibility for notifying all radiologists in their State of the information contained

in this bulletin. The names of radiologists appointed to the Medical Advisory Boards, of which there will be several in each State, can be obtained from the Adjutant General's office in your State. This list may also be obtained from the Medical Preparedness chairman of your State society. Will you please make it your duty to see that this information is placed in the hands of all radiologists so appointed?

We respectfully suggest also that the recipients of this bulletin in the various States assume the responsibility of providing a list of qualified radiologists available for examination of draftees to the Adjutant General in your State. His office, in turn, can relay this information to the respective Selective Service Boards and Medical Advisory Boards.

As additional information is received at this office, it will be forwarded to you in subsequent bulletins. Meanwhile, we shall depend upon you to disseminate this information in your locality. A special meeting of your State or regional radiological society might be advisable. If further questions occur to you, please do not hesitate to call upon this office for any information we may be able to give you.

*Cost Schedules for Selective Service Examinations (Nov. 1, 1940).*—In our Bulletin of October 29, we reported that a subcommittee of the A. M. A. Committee on Medical Preparedness was preparing a schedule of costs, upon the basis of which radiologists would be reimbursed for actual expenses incurred in performing examinations on draftees. It now appears that no national schedule will be prepared. Instead, the local Committee on Medical Preparedness of the various State medical societies will draw up schedules of cost-fees for the respective States. The schedule for New York State has already been adopted.

We suggest that you communicate with the chairman of your State Committee on Medical Preparedness relative to the schedule for your State. Perhaps it will be desirable to appoint a special committee of radiologists to prepare and submit the schedule. It should include a reasonable and representative list of cost-fees for all procedures likely to be performed on draftees and be suitable for all sections of the State.

Please forward to this office (The American College of Radiology, 540 North Michigan Avenue, Chicago) the schedule adopted for your State as soon as it is available.

In some localities radiologists have agreed among themselves to assume the costs for these examinations as a patriotic contribution to the cause of military preparedness. The probabilities are that, in most localities, no great number of roentgen examinations will be requested, either on the order of examining physicians or the local Medical Advisory Boards. A. C. Christie, M.D., Chairman of the Advisory Committee for Radiology of the National Research Council, believes that the burden on any individual radiologist will, in most instances, be small.

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The following information will be of interest to radiologists within the draft age in your locality. It is understood that all physicians drafted will be given posts appropriate to their specialty, if any, when inducted into the Medical Corps. The Surgeon-General of the Army will obtain information regarding specialists from the A. M. A. Committee on Medical Preparedness. The American College of Radiology, the American Board of Radiology, and the Advisory Committee for Radiology of the National Research Council will assist the A. M. A. Committee in determining qualifications of all those listing themselves as radiologists on the A. M. A. questionnaire. When inducted into service, a radiologist should immediately notify the local Corps Area Commander of his preference for roentgenology.

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# RADIOLOGICAL SOCIETIES IN NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

## UNITED STATES

### CALIFORNIA

*California Medical Association, Section on Radiology.—Chairman,* Carl H. Parker, M.D., 65 N. Madison Ave., Pasadena; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd., Los Angeles.

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*Los Angeles County Medical Association, Radiological Section.—President,* M. L. Pindell, M.D.; *Vice-president,* Richard T. Taylor, M.D.; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd.; *Treasurer,* Henry Snure, M.D., 1414 South Hope Street; Kenneth Davis, M.D., *Member of Executive Committee.* Meets second Wednesday of each month at County Society Building.

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*Pacific Roentgen Society.—Chairman,* William E. Costolow, M.D., Los Angeles; *Members of Executive Committee,* I. S. Ingber, M.D., San Francisco; D. R. MacColl, M.D., Los Angeles, and J. D. Coate, M.D., Oakland; *Secretary-Treasurer,* L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Society meets annually during annual meeting of the California Medical Association.

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*San Francisco Radiological Society.—Secretary,* Harold A. Hill, M.D., 450 Sutter Street. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (Univ. of Calif. Med. School) and for the second six months at Lane Hall (Stanford Univ. School of Med.).

### COLORADO

*Denver Radiological Club.—President,* N. B. Newcomer, M.D., 306 Republic Bldg.; *Vice-president,* Elizabeth Newcomer, M.D.; *Secretary,* Paul R. Weeks, M.D., 520 Republic Bldg.; *Treasurer,* L. G. Crosby, M.D., 366 Metropolitan Bldg. Meets third Friday of each month at homes of members.

### CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.—Chairman,* Owen J. Groark, M.D., 881 Lafayette St., Bridgeport; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

### DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

### FLORIDA

*Florida Radiological Society.—President,* J. H. Lucinian, M.D.; *Vice-president,* John N. Moore, M.D.; *Secretary-Treasurer,* Elliott M. Hendricks, M.D., 314 Sweet Bldg., Fort Lauderdale. The next meeting will be at the time of the annual meeting of the Medical Association of Florida in the spring.

### GEORGIA

*Georgia Radiological Society.—President,* Robert Drane, M.D., DeRenne Apts., Savannah; *Vice-president,* J. J. Collins, M.D., Archbold Hospital, Thomasville; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

### ILLINOIS

*Chicago Roentgen Society.—President,* Adolph Hartung, M.D.; *Vice-president,* Warren W. Furey, M.D.; *Secretary,* Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

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*Illinois Radiological Society.—President,* Harry W. Ackeman, M.D., 321 W. State St., Rockford; *Vice-president,* D. R. Hanley, M.D., St. Mary's Hospital, Streator; *Secretary-Treasurer,* William DeHollander, M.D., St. John's Hospital, Springfield. Meetings quarterly by announcement.

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*Illinois State Medical Society, Section on Radiology.—Chairman,* Harry W. Ackeman, M.D., 321 W. State St., Rockford; *Secretary,* Earl E. Barth, M.D., 303 E. Chicago Ave., Chicago.

### INDIANA

*The Indiana Roentgen Society.—President,* H. H. Inlow, M.D., Shelbyville; *President-elect,* Charles Wyeth, M.D., Terre Haute; *Vice-president,* C. A. Stayton, M.D., Indianapolis; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

### IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

### KENTUCKY

*Kentucky Radiological Society.—President,* D. B. Harding, M.D., Lexington; *Vice-president,* I. T. Fugate, M.D., Louisville; *Secretary-Treasurer,* Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

### MAINE

*See* New England Roentgen Ray Society.

MARYLAND

*Baltimore City Medical Society, Radiological Section.—Chairman,* John W. Pierson, M.D., 1107 St. Paul St.; *Secretary,* Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

The Thirty-first Annual Midwinter Conference of Eastern Radiologists will meet in Baltimore on Jan. 31 and Feb. 1, 1941.

MASSACHUSETTS

*See* New England Roentgen Ray Society.

MICHIGAN

*Detroit X-ray and Radium Society.—President,* O. J. Shore, M.D., 552 Fisher Bldg., Detroit; *Vice-president,* Clarence E. Hufford, M.D., 421 Michigan St., Toledo, Ohio; *Secretary-Treasurer,* E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

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*Michigan Association of Roentgenologists.—President,* J. H. Dempster, M.D., Detroit; *Vice-president,* L. E. Holly, M.D., Muskegon; *Secretary-Treasurer,* J. E. Lofstrom, M.D., 1536 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

*Minnesota Radiological Society.—President,* Harry Weber, M.D., Mayo Clinic, Rochester; *Vice-president,* G. T. Nordin, M.D., Minneapolis; *Secretary,* John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

*The Kansas City Radiological Society.—President,* L. G. Allen, M.D., 907 N. 7th St., Kansas City, Kansas; *Secretary,* Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

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*The St. Louis Society of Radiologists.—President,* Oscar C. Zink, M.D., St. Luke's Hospital; *Secretary,* Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president

NEBRASKA

*Nebraska Radiological Society.—President,* Roy W. Fouts, M.D., 1007 Medical Arts Bldg., Omaha; *Secretary,* D. Arnold Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

*See* New England Roentgen Ray Society.

NEW JERSEY

*Radiological Society of New Jersey.—President,* James G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Vice-president,* Nathan J. Furst, M.D., 190 Johnson Ave., Newark; *Secretary,* W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer,* H. A. Vogel, M.D., 1060 East Jersey St., Elizabeth, and *Counsellor,* H. J. Perlberg, M.D., 921 Bergen Ave., Jersey City. Meetings at Atlantic City at time of State Medical Society and Midwinter in Newark as called by president.

NEW YORK

*Associated Radiologists of New York, Inc.—President,* I. J. Landsman, M.D., 910 Grand Concourse, New York City; *President-elect,* D. E. Ehrlich, M.D., 35 West 92nd St., New York City; *Vice-president,* Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer,* Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary,* William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

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*Brooklyn Roentgen Ray Society.—President,* A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.; *Secretary-Treasurer,* L. J. Taormina, M.D., 1093 Gates Ave. Meetings held the fourth Tuesday of every month, October to April.

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*Buffalo Radiological Society.—President,* Edward Koenig, M.D., 100 High St., Buffalo; *Vice-president,* W. Roger Scott, M.D., 598 Pine St., Niagara Falls; *Secretary-Treasurer,* Joseph S. Gian-Franceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

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*Central New York Roentgen Ray Society.—President,* Albert Lenz, M.D., 613 State St., Schenectady; *Vice-president,* Dwight V. Needham, M.D., 123 Sedgwick St., Syracuse; *Secretary-Treasurer,* Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

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*Long Island Radiological Society.—President,* Samuel G. Schenck, M.D., Brooklyn; *Vice-president,* G. Henry Koiransky, M.D., Long Island City; *Secretary,* Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer,* Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

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*New York Roentgen Society.—President,* Henry K. Taylor, M.D., 667 Madison Ave., New York City;

*Vice-president*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains, N. Y.; *Secretary*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City, and *Treasurer*, Paul C. Swenson, M.D., 168th St. and Broadway, New York City.

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*Rochester Roentgen-ray Society.—Chairman*, George H. S. Ramsey, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

*Radiological Society of North Carolina.—President*, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

*Ohio Radiological Society.—President*, U. V. Portmann, M.D., Cleveland; *Secretary*, J. E. McCarthy, M.D., Cincinnati. A committee was appointed to draw up a constitution and by-laws. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

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*Cleveland Radiological Society.—President*, L. A. Pomeroy, M.D., Hanna Bldg., Cleveland; *Vice-president*, P. C. Langan, M.D., 215 Wellesley Ave., Akron; *Secretary-Treasurer*, H. A. Mahrer, M.D., 10515 Carnegie Ave., Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

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*Radiological Society of the Academy of Medicine* (Cincinnati Roentgenologists).—*President*, Samuel Brown, M.D.; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

*Pennsylvania Radiological Society.—President*, H. Norton Mawhinney, M.D., Pittsburgh; *President-elect*, Peter B. Mulligan, M.D., Ashland; *First Vice-president*, Harold S. Callen, M.D., Bradford; *Second Vice-president*, Harold W. Jacox, M.D., Pittsburgh; *Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport; *Editor*, William E. Reiley, M.D., Clearfield; *Assistant Editor*, Sydney J. Hawley, M.D., Danville; *Censor for Three Years*, A. R. Snedden, M.D., McKeesport. The Society meets annually; time and place of next meeting will be announced later.

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*The Philadelphia Roentgen Ray Society.—President*, Jacob H. Vastine, II, M.D., Medical Arts Bldg., Philadelphia; *Vice-president*, A. Maxwell Sharpe, M.D., 708 Sproul St., Chester; *Secretary*, Barton R. Young, M.D., Temple University Hospital, Philadelphia; *Treasurer*, Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

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*The Pittsburgh Roentgen Society.—President*, Paul G. Bovard, M.D., 306 Corbett St., Tarentum, Pa.; *Vice-president*, John H. Gemmell, M.D., 262 Connecticut Ave., Rochester, Pa., and *Secretary-Treasurer*, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings held second Wednesday of each month at 4:30 P.M., from October to June, at various hospitals designated by program committee.

RHODE ISLAND

*See* New England Roentgen Ray Society.

SOUTH CAROLINA

*South Carolina X-ray Society.—President*, T. A. Pitts, M.D., Columbia; *Secretary-Treasurer*, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

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*Tennessee Radiological Society.—President*, Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Vice-president*, Christopher C. McClure, M.D., 404 Doctors Bldg., Nashville; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

*Texas Radiological Society.—President*, C. F. Crain, M.D., Corpus Christi; *President-elect*, M. H. Glover, M.D., Wichita Falls; *First Vice-president*, G. D. Carlson, M.D., Dallas; *Second Vice-president*, P. E. Wigby, M.D., Dallas; *Secretary-Treasurer*, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually. The next annual meeting is to be Jan. 18, 1941, in Sherman.

VERMONT

*See* New England Roentgen Ray Society.

VIRGINIA

*Virginia Radiological Society.—President*, Wright Clarkson, M.D., Petersburg; *Vice-president*, Clayton

W. Ely, M.D., Norfolk; *Secretary*, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

*Washington State Radiological Society.—President*, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Vice-president*, George Cornett, M.D., Yakima; *Secretary-Treasurer*, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

*Milwaukee Roentgen Ray Society.—President*, H. W. Hefke, M.D.; *Vice-president*, Frederick C. Christensen, M.D.; *Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

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*Radiological Section of the Wisconsin State Medical Society.—Secretary*, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

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*University of Wisconsin Radiological Conference.—Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301 Service Memorial Institute.

CANADA

*Section on Radiology, Canadian Medical Association.—Chairman*, Gordon Richards, M.D., Medical Arts Bldg., Toronto; *Secretary*, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

*Section on Radiology, Ontario Medical Association.—Chairman*, E. H. Shannon, M.D., St. Michael's Hospital, Toronto; *Secretary*, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

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*Canadian Association of Radiologists.—President*, J. E. Gendreau, M.D., Montreal; *Vice-president*, W. H. McGuffin, M.D., Calgary; *Honorary Secretary-Treasurer*, W. L. Ritchie M.D., Montreal; *Chairman of Interrelations Committee*, G. E. Richards, M.D., Toronto.

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*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales* held a meeting at Quebec on Sept. 28, 1940, at which time the following officers were elected for the next two years: *President*, Albert Comtois, M.D., Hôpital Ste.-Justine, Montreal; *First Vice-president*, Jules Gosselin, M.D., Hôpital St.-Sacrement, Quebec; *Second Vice-president*, Paul Brodeur, M.D., General Hospital, Ottawa; *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal, and *General Treasurer*, Doriva Léonard, M.D., Hôpital Notre Dame, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

*Sociedad de Radiologia y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

# EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

## ROENTGEN DIAGNOSIS OF EMERGENCY CONDITIONS

That there should be any doubt in this day concerning the necessity for emergency service in the radiological department of any hospital seems incredible, yet such an opinion is still widely held. Recently one of the foremost hospital organizers in the country, referring specifically to technical service, wrote as follows: "So far as x-ray work is concerned there is practically no need for an emergency service. I cannot state any instance or type of case wherein an emergency x-ray examination is required. . . . . it is most rare that an x-ray examination cannot be postponed for at least 24 hours without damage or danger to the patient. . . . . Such work, however (out of regular hours), should only embrace the skeletal system."

No statement could be further from the truth; fortunately, the author of the above quotation has graciously retracted it *in toto*. It is significant, however, that his opinion was originally derived, not from the advice of clinicians, but rather as a result of consultation with roentgenologists. Casual inquiry suggests that too many physicians, hospital superintendents, and roentgenologists still share this viewpoint.

Without doubt, immediate roentgenography in the case of many fractures is unnecessary, except as a concession to the anxiety of the patient or his family. In some instances, notably in the case of skull fractures, it is not only unnecessary but probably distinctly harmful. The fact is that an acute situation in regard to the skeleton is the least important of the indications for emergency roentgen study.

The necessity for the immediate roentgen examination of patients with acute pulmonary and abdominal conditions is much more imperative. In no better way, for example, can the diagnosis of pneumonia be established at an early period. We have observed definite roentgen findings as early as three hours after the onset of pneumonia, and not rarely in from six to eight hours. At this early period the physical findings may be absent, the clinical symptomatology may not be specific, and sputum-typing may be impossible. Yet specific treatment—whether it be chemo- or serotherapy—should not be entered upon lightly; for obvious reasons, patients with a fever resulting from causes other than pneumonia should not be treated in such radical fashion. Likewise, in the post-operative pulmonary complications, such as atelectasis, it is important to institute therapy at the earliest possible moment; here, too, no surer and earlier means of diagnosis is at hand.

In the realm of the acute abdominal conditions, most of which connote a surgical emergency, immediate roentgen examination is also of the first importance. The list of diseases amenable to roentgen study, those in which the findings obtained are of great assistance in the determination of the nature of the pathologic process, includes almost all the acute abdominal diseases. Notable amongst these are acute appendicitis, acute renal colic, perforation of a hollow viscus, acute intestinal obstruction, trauma to the abdomen, peritonitis, intraperitoneal abscess, and placenta prævia. In all such cases urgent therapeutic measures must be undertaken and immediate diagnosis is pressing. Careful consideration of the roentgen findings adds immeasurably to the ability of the surgeon to proceed in a rational fashion toward the treatment of such abdominal catastrophies.

It should be unnecessary to add that roentgenography by a technician will not suffice. No more difficult field of roentgen interpretation exists and it should not be left to clinicians or internes. The observations and judgment of an experienced roentgenologist will add tremendously to the early diagnosis and the intelligent assessment of the situation. It is

important that roentgenologists make perfectly evident to their staff associates, not only their willingness, but also their desire, regardless of the hour, to participate in the diagnosis of any case for which roentgen examination is indicated.

LEO G. RIGLER, M.D.

# ANNOUNCEMENTS

## INSTITUTE FOR RADIOLOGISTS

COLLEGE OF MEDICINE, SYRACUSE UNIVERSITY, SYRACUSE, NEW YORK
JAN. 18, 1941

2:00 P.M.
Physics of Radiation for the Radiologist. MRS. EDITH H. QUIMBY

3:00 P.M.
Roentgenologic Aspects of Brain Tumors: Diagnosis and Treatment. MERRILL C. SOSMAN, M.D.

3:45 P.M.
Indications and Results of Roentgen Therapy. URSUS V. PORTMANN, M.D.

4:45 P.M.
Radiosensitivity of Tumors. FRED W. STEWART, M.D.

5:30 P.M.
The Cyclotron. STAFFORD L. WARREN, M.D.

6:30 P.M.
Dinner, Small Ballroom, Hotel Syracuse.
Speaker, R. R. SPENCER, M.D., Assistant Chief, National Cancer Institute of the United States Public Health Service, Washington, D. C.

## MEDICAL TECHNICIANS SOUGHT FOR WAR DEPARTMENT

Medical technicians experienced in surgical and x-ray work are needed by the War Department. The United States Civil Service Commission has announced an examination to fill these positions in the following grades and optional subjects: Senior medical technician (roentgenology) $2,000 a year; medical technician (roentgenology, and surgical), $1,800 a year; assistant medical technician (roentgenology, and surgical), $1,620 a year. The salaries are subject to a retirement deduction of 3.5 per cent.

Applications must be on file with the Commission's Washington office not later than November 28, if received from States east of Colorado, and not later than December 1, 1940, if received from Colorado and States westward.

Applicants must have completed a 4-year high-school course, unless they pass a written general test, and, in addition, they must have had responsible experience in surgical duties in an operating room or clinic, or in x-ray work including x-ray photography and posturing, and in the installation and maintenance of x-ray apparatus. Appropriate college study may be substituted for part of the required experience. With the exception of those who have not completed the high-school course, applicants will not be given a written test. All competitors will be rated on their qualifications as shown in their applications and on corroborative evidence.

Detailed information regarding the examinations and the proper application forms may be obtained from the Secretary of the U. S. Civil Service Examiners at any first- or second-class post office or from the United States Civil Service Commission, Washington, D. C.

# COMMUNICATIONS

## AMERICAN INSTITUTE OF PHYSICS

Progress and problems in one of the most rapidly moving and promising fields of modern science, nuclear physics, was discussed at a special conference held under the auspices of the American Institute of Physics at the Massachusetts Institute of Technology in October.

Nuclear physics is the investigation of physical phenomena which occur within the nucleus or core of atoms, the tiny building blocks of which all matter is composed. Scientists have discovered that many of these phenomena can be harnessed for man's use, and it is the various diverse practical applications of this branch of science to which the conference devoted most of its attention.

Dr. Karl T. Compton, President of the Massachusetts Institute of Technology, addressed the conference: Dr. Paul E. Klopsteg, Chairman of the American Institute of Physics,

responded. The technical session which followed was devoted to the measurement and production of radio-active and stable isotopes and of penetrating radiations. The chairman of this session was Dr. Edmund U. Condon, of the Westinghouse Electric and Manufacturing Company, and papers were presented by Dr. M. A. Tuve, Carnegie Institution of Washington; Dr. Harold C. Urey, Columbia University, and Dr. John G. Trump, of the Massachusetts Institute of Technology (M. I. T.). Dr. Enrico Fermi, the distinguished physicist of Columbia University, and winner of the Nobel Prize for his achievements in nuclear disintegration, was also a speaker on recent advances in physics. Sessions covered the fields of chemistry, radiology, and biology, and there was an evening lecture on the biologic effects of radiation. Papers on radiology and biology were the subject of sessions, with a lecture on "The General Results of Biologic Studies with Tracer Isotopes." Studies of plant metabolism with radio-active isotopes were considered.

The committee in charge of the Conference included Dr. Robley D. Evans, of the Department of Physics at M. I. T., *Chairman;* Dr. Elmer Hutchisson, of the University of Pittsburgh, *Secretary;* Dr. Henry A. Barton, Director of the American Institute of Physics; Dr. Edward U. Condon, of the Westinghouse Electric and Manufacturing Company; Dr. Lee A. DuBridge, University of Rochester, Dr. G. Failla, Memorial Hospital, New York City; Dr. Clark Goodman, Department of Physics, M. I. T.; Dr. Ernest O. Lawrence, the distinguished physicist of the University of California, who was awarded the Nobel Prize for the development of the cyclotron, and Dr. Harold C. Urey, of Columbia University, whose discovery of heavy water won for him the Nobel Prize.

Among the distinguished scientists who were chairmen of the various technical sessions were: Dr. James B. Conant, President of Harvard University; Dr. Lyman J. Briggs, National Bureau of Standards; Dr. F. Seitz, University of Pennsylvania; Dr. S. C. Lind, University of Minnesota; Dr. C. S. Barrett, Carnegie Institute of Technology, Pittsburgh; Dr. A. C. Lane, Tufts College; Dr. H. S. Taylor, Princeton University; Dr. G. W. Holmes, Massachusetts General Hospital; Dr. J. H. Means, Massachusetts General Hospital, Harvard University; Dr. L. H. Adams, Carnegie Institution of Washington; Dr. H. C. Urey, Columbia University; Dr. G. E. Pfahler, University of Pennsylvania; Dr. J. C. Aub, Huntington Memorial Hospital, Harvard University; Dr. K. T. Bainbridge, Harvard University; Dr. G. Failla, Memorial Hospital, New York City; Dr. R. H. Stevens, Detroit, Mich.; Dr. J. G. Hamilton, University of California; Dr. Edith H. Quimby, Memorial Hospital, New York City; Dr. S. L. Warren, University of Rochester Medical School; Dr. Charles Packard, Columbia University; Dr. D. W. Bronk, Cornell University Medical School; Dr. D. R. Goddard, University of Rochester, and Dr. Robert J. Van de Graaff, of M. I. T.

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## AMERICAN PUBLIC HEALTH ASSOCIATION

The registered attendance at the Sixty-ninth Annual Meeting of the American Public Health Association and meetings of related organizations, held in Detroit during the week of October 7, was 3,187, the second largest in the Association's history. Delegates came from every State in the Union, the District of Columbia, Alaska, Hawaii, Puerto Rico, Canada, Cuba, Mexico, Denmark, China, and New Zealand.

The officers elected for the year 1940-1941 are as follows: *President:* W. S. Leathers, M.D., Nashville, Tenn.; *President-elect:* John L. Rice, M.D., New York City; *Vice-presidents:* Robert D. Defries, M.D., Toronto, Canada, Charles Edward Finlay, M.D., Havana, Cuba, and Selskar Gunn, New York City; *Treasurer:* Louis I. Dublin, Ph.D., New York City; *Chairman of Executive Board:* Abel Wolman, Dr.Eng., Baltimore, Md., and *Executive Secretary:* Reginald M. Atwater, M.D., New York City.

A Committee on Public Health in the National Defense was appointed with the following personnel: W. S. Leathers, M.D., *Chairman;* Stanley H. Osborn, M.D.; Huntington Williams, M.D., and Abel Wolman, Dr.Eng.

Among the resolutions passed was one emphasizing the necessity for maintaining civilian health as essential in national defense and pledging the united support of members to the national defense and to the maintenance of health in a free people.

The Seventieth Annual Meeting will be held in Atlantic City, N. J., in October, 1941.

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J. J. CLARK, M.D., of Atlanta, Ga.
M. L. CONNELLY, M.D., of Chicago
SYDNEY J. HAWLEY, M.D., of Danville, Penna.
LEWIS G. JACOBS, M.D., of Winona, Minn.
EUGENE T. LEDDY, M.D., of Rochester, Minn.
ANTONIO MAYORAL, M.D., of New Orleans, La.
HAROLD O. PETERSON, M.D., of Madison, Wisc.
ERNEST A. POHLE, M.D., PH.D., of Madison, Wisc.
SIMON POLLACK, M.D., of Oklahoma City, Okla.
ERNST A. SCHMIDT, M.D., of Denver, Colo.
CHARLES G. SUTHERLAND, M.D., of Rochester, Minn.
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## THE ABDOMEN

Diagnosis of the Acute Surgical Abdomen in Children. A. W. Carley. Ohio St. Med. Jour., **35,** 1056–1058, October, 1939.

In discussing the various pathologic entities manifesting acute abdominal pain in children, the author relates numerous cases illustrating differential diagnostic criteria. He mentions the importance of skiagraphy in differentiating between right basal chest pathology and appendicitis in children. The diagnostic aid of roentgen examination is also considered in such conditions as intussusception, obstruction, and terminal ileitis.

SIMON POLLACK, M.D.

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Roentgenologic Examination of Acute Abdominal Lesions. J. Frimann-Dahl. Acta Radiol., **20,** 438–451, November, 1939.

Frimann-Dahl is of the opinion that the feasibility and diagnostic importance of emergency roentgenography of acute abdominal lesions—the "roentgenologie d'urgence" of the French—is still too little known to, and consequently too little practised by, the rank and file of radiologists. The author examined during the course of three years 488 cases of acute abdominal lesions which were subdivided as follows: perforated ulcers, 41 cases; conditions of ileus, 160 cases; volvulus of the colon, 13 cases; ureteral stones, 262 cases, and traumatic renal lesions, 12 cases.

In addition, cases of pancreatitis, cholecystitis, paranephritis, intraperitoneal abscesses, intussusception, and similar conditions were occasionally observed.

The fluoroscopic and roentgenographic examinations followed the technic previously described and advocated by Laurell. Intimate co-operation between the surgical service of the hospital and the x-ray department is essential.

ERNST A. SCHMIDT, M.D.

## ABSCESS, PERINEPHRIC

Perinephric Abscess. E. L. Shiflett. Kentucky Med. Jour., **37,** 282–285, July, 1939.

Shiflett presents a summary of his experiences with perinephric abscess, and clearly states that he does not attempt to distinguish between perinephritic, paranephritic, and perinephric or perirenal abscesses. He considers the perinephrium as an individual organ with its own anatomic characteristics. From his experience, he is led to believe that "every perinephric abscess is preceded, sometimes for considerable periods of time, by an acute or chronic stage of inflammatory infiltration without actual necrosis and that in some instances a roentgen diagnosis of infection of the perinephrium can be made before pus is actually present."

These abscesses may be renal or non-renal in origin, each type presenting different diagnostic problems, and although roentgenology is a very efficient method of diagnosis or of localizing the abscess it is not absolutely foolproof.

Aware of the difficulty of clinical diagnosis, the writer points out the pitfalls in roentgenologic diagnosis, and emphasizes the advisability of careful interpretation on a pathologic basis, as well as the employment of all available methods. In the presence of acute ureteral obstruction or acute infection of the kidney or its capsule, the kidney shadows will appear enlarged, due to the edema, hyperemia, and swelling of the organ and its capsule. The signs which accompany such a lesion are psoas muscle spasm and scoliosis, with concavity to the affected side, splinting of the diaphragm and the lower half of the corresponding hemothorax, with decreased aeration of the base of the lung. Elevation of the diaphragm, flaring of the lower ribs, displacement of the kidney and of the colic flexures, or inconstant ileus localized to the involved quadrant may be caused by the peritoneal irritation. Sometimes all of these signs are present, but most often some combination of them is found. They indicate infection in the kidney or its surrounding tissue. To localize the lesion, however, one must go further.

Suspecting renal or perirenal pathology, pyelograms in anteroposterior and lateral positions are made. If these are normal but the kidney is found displaced forward, or if either the upper or lower pole is displaced forward or outward, the examiner is justified in establishing the diagnosis of primary perinephric abscess. However, if the above findings are accompanied by a pyelogram showing any one of the various kidney infections, the diagnosis of secondary perinephric abscess would be correct.

ANTONIO MAYORAL, M.D.

## ANIMAL EXPERIMENTATION

Radiography in Zoölogical Research. F. C. Fraser. British Jour. Radiol., **12,** 432–439, July, 1939.

Radiography is particularly useful to the zoölogical anatomist in studying the skeleton, as it saves long and tedious dissections and eliminates the possibility of losing small bones. The article is accompanied by illustrations showing the application of radiography.

SYDNEY J. HAWLEY, M.D.

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The Biological Measurement of Gamma Rays in "Equivalent Roentgens" with Mouse Sarcoma as the Test Object. Kanematsu Sugiura. Am. Jour. Cancer, **37,** 445–452, November, 1939.

Small fragments of the tumor were placed in a special moist cellophane chamber and irradiated with 200 kv. x-rays at 50 cm. distance with 0.5 mm. copper and 1.6 mm. aluminum filter, 30 ma., and 59 r/min. Other fragments of the tumor were irradiated with radon placed in containers of platinum of 0.5 mm. thickness in a bakelite sphere at a distance of 1 cm.

A dose of 500 r had no effect on the tissue when it was transplanted, but with 3,000 r the viability of the tumor was completely destroyed.

Irradiation with 5,000 and 10,000 millicurie-minutes had no appreciable effect, but 30,000 millicurie-minutes destroyed completely the viability of the tumor.

The survival curves obtained for 200 kv. x-rays and gamma rays showed an almost identical course, indi-

cating that the nature of the effect produced by hard x-rays and gamma rays on Mouse Sarcoma 180 irradiated *in vitro* is essentially the same. An "equivalent roentgen" value for gamma rays of from 96 to 114 r/min./gm. was obtained for the standard conditions of 1 cm. distance from an effective point source of gamma radiation with a filtration of 0.5 mm. platinum.

HAROLD O. PETERSON, M.D.

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Effect of Thymus Transplants on Tumor Growth. Maynard Murray. Jour. Lab. and Clin. Med., **24,** 1247–1250, September, 1939.

The author reports the inoculation of a number of rats with a transplantable tumor of the breast. He then transplanted thymus from rats and dogs into the cancer rats and found the thymus transplant to exert marked inhibition of tumor growth, causing the tumors to be absorbed, in a high percentage of cases. Calf thymus did not show much effect. The thymus was observed uniformly to be extra large in rats found immune to tumor transplants.

WILLIS A. WARD, M.D.

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The Effect of a Single Dose of X-rays on the Bone Marrow of the White Mouse. H. Langendorff and W. Papperitz. Strahlentherapie, **65,** 624–629, 1939.

The authors exposed the entire body of three-month-old white male mice to roentgen rays given in one sitting (180 kv., 4 ma., 0.5 mm. Cu, 21 r/min.; dose administered, 400 r). After the normal figures for the bone marrow of the mouse had been established, the irradiated bone marrow was studied histologically, beginning 30 minutes after the exposure and up to 100 days later. The changes observed are recorded in graphs and cover the variations of the various elements found in the bone marrow. It appears that the reaction occurs in cycles, definite karyolysis being seen as early as two or three hours following the exposure. Approximately 100 days following irradiation, the normal status of the bone marrow has been established.

ERNST A. POHLE, M.D., Ph.D.

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The Effect of Gamma Radiation on Cells *in vivo*.—Part II. A. Glücksmann and F. G. Spear. British Jour. Radiol., **12,** 486–498, August, 1939.

In Part I it was shown that there was a diminution in mitosis followed by degeneration in the cells of tadpoles after a single exposure to gamma rays. From this it was concluded that the radiation unfitted the cells for division. To check the conclusions from Part I, fasting tadpoles and those kept at low temperatures were irradiated.

Fasting greatly modifies the effect of radiation by reducing the number of actual and potential dividing cells. Therefore, in the fasting animal there should be a decrease in the amount of degeneration. This was confirmed by the experiments. When animals were irradiated during the fasting period, subsequent feeding was followed by an immediate appearance of a few degenerate cells followed by a slight rise in mitosis in five days. This rise is appreciably less than in unirradiated animals. The appearance of degeneration before mitosis suggests that breakdown occurs at a very early stage of pre-mitotic activity. If two weeks, fasting follows irradiation, no degeneration appears during the first three days of feeding.

When a dose of radiation sufficient to produce marked degeneration in an animal at room temperature is given to chilled animals, no degeneration is seen as long as the animal is kept cold, but when it is brought to room temperature degenerated cells appear in about six hours.

These results confirm the conclusions drawn from earlier experiments, namely, that degeneration seen after relatively small doses of radiation is correlated with the presence of potentially dividing cells which are unable to accomplish mitosis owing to damage caused by the exposure and breakdown on attempted division.

SYDNEY J. HAWLEY, M.D.

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The Avoidance of X-ray Leukopenia. C. Carrie and O. Schnettler. Strahlentherapie, **66,** 149–154, 1939.

The authors studied the effect of vitamin C on the prevention of roentgen leukopenia in rabbits. It appeared that large doses of vitamin C may produce leukocytosis and that if leukopenia developed during irradiation it was considerably improved by vitamin C medication. For that reason the authors recommend its administration before irradiation.

ERNST A. POHLE, M.D., Ph.D.

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Biological Effects of Gamma Radiation.—Series II. S. Russ and G. M. Scott. British Jour. Radiol., **12,** 440,441, July, 1939.

Male and female rats were exposed to gamma radiation continuously for 168 days, except for two consecutive days each week. The dose is estimated at 1,480 r for each rat. The death rate for the irradiated rats was 45.8 per cent and for the controls, 14.8 per cent. The irradiated rats aged more quickly. The breeding power of the irradiated rats was greatly diminished. Abortions were frequent. Many offspring died at birth.

SYDNEY J. HAWLEY, M.D.

## APPARATUS

An Optical Device for the Accurate Alignment of an X-ray Beam. W. V. Mayneord. British Jour. Radiol., **12,** 257, 258, May, 1939.

A Simple Apparatus for the Rapid Positioning of Certain Deep Therapy Cases. S. B. Adams. British Jour. Radiol., **12,** 259, May, 1939.

These two articles describe similar apparatus by which the patient may be correctly aligned with the beam by means of an optical arrangement which shows the emergent beam accurately.

SYDNEY J. HAWLEY, M.D.

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Stereoradiography in Head Injuries. Ernst Baumann. Schweiz. med. Wchnschr., **69,** 930, Oct. 14, 1939.

The necessity of roentgen study in head injuries is

unquestioned, but too great economy in the use of films may greatly reduce the value of such work. Stereoscopic studies in at least two planes are essential. Expensive stereoscopes may be dispensed with; one can improvise such equipment quite readily. Stereoscopic vision can be easily learned with a little practice. The improvement in accuracy of results thus obtained in the study of head injuries would demand the increased employment of stereoscopy.

LEWIS G. JACOBS, M.D.

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A Radium Needle-threading Apparatus. R. Kaye Scott. British Jour. Radiol., **12,** 559–561, September, 1939.

Directions are given for making a lead block which holds various sized needles with only the eye showing and which gives the operator protection.

SYDNEY J. HAWLEY, M.D.

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A Radium Plaque Accessory. R. Kaye Scott. British Jour. Radiol., **12,** 562, 563, September, 1939.

Directions are given for making a lead block which holds a radium plaque while applying the rubber cover so that the operator's fingers are not unduly exposed.

SYDNEY J. HAWLEY, M.D.

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A Dose Contour Projector and its Application to Three-dimensional Radiation Distributions. W. V. Mayneord. British Jour. Radiol., **12,** 262–268, May, 1939.

An apparatus is described by means of which it is possible with the depth dose curves in common use to determine the distribution of radiation in three dimensions. It is also possible to determine the distribution along a plane not parallel to the central ray.

The application and the curves derived are discussed in the succeeding papers in the same issue of the *British Journal of Radiology.*

SYDNEY J. HAWLEY, M.D.

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Arrangements for the Use of the 600 kv. Tube of the Institute for Cancer of the Faculté de Médicine de Paris. J. Belot and L. Dauvilliers. Bull. et mém. Soc. de radiol. méd. de France, **27,** 62–67, February, 1939.

In this article the authors describe the mounting of a 600 kv, oil-cooled tube previously described (*Jour. de radiol. et d'electrol.*, p. 457, October, 1937) and the arrangment of the operating controls.

Operating at 80 cm. S.T.D., 500 kv., 10 ma., filter of 2 mm. Cu plus the inherent filtration, the output is 45 r per minute. The depth dose at 10 cm. in a rice phantom is 54 per cent.

S. R. BEATTY, M.D.

## BILIARY TRACT

Unusual Appearances of the Biliary Tract. P. Porcher. Arch. d. mal. de l'app. digestif, **29,** 213–216, February, 1939.

Among the unusual cases which have been brought to the author's attention is one in which the entire biliary tract is outlined by air or gas. Such a condition could be caused by a fistula between the biliary tract and intestine, by insufficiency of the ampulla of Vater, or by the presence of gas-forming organisms. In another case, a type less rare in his experience, just such an insufficiency of the sphincter and ampulla was repeatedly demonstrated after a barium meal.

In another patient, who coughed up bile on occasion, a biliary-pleural-bronchial fistula could be demonstrated. The patient seemingly suffered no ill effects.

S. R. BEATTY, M.D.

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End-results Following Common Duct Obstruction. Fred M. Douglass. Ohio St. Med. Jour., **35,** 938–943, September, 1939.

The author reviews a series of 209 cases of common duct disease which were operated on, 93 cases of which were studied by post-operative cholangiography with opaque oil. The usual technic was injection of brominol 20 c.c. by gravity, the tenth or twelfth post-operative day, under fluoroscopic observation, and checking this study with roentgenograms.

The surgical problem involves the removal of the biliary obstruction; treating and managing the infection in and around the biliary duct system; establishing free flow of bile into the intestinal tract, and, lastly, preventing recurrence of the original disease. Douglass first reported his experience with cholangiography in 1932, and with further use has found it invaluable in following the course of these patients. He feels that preoperative preparation is important, especially the administration of fluids, glucose, blood, vitamin K, and bile. Surgery should be performed without delay. The use of biliary drainage has been the only effective method in his experience in treating cholangeitis and hepatitis. The longer the history of symptoms, the more chronic and widespread are these changes in the hepatic radicles and the liver itself.

SIMON POLLACK, M.D.

## BONE DISEASES (DIAGNOSIS)

Osteopsathyrosis (Fragilitas Ossium), with Report of a Case. H. H. McGarry. Canadian Med. Assn. Jour., **41,** 354–356, October, 1939.

Osteopsathyrosis in a baby one day old is reported. Multiple fractures, some with callus formation, were noted on films made 12 hours after birth.

Microscopic study of one fracture site showed old hemorrhage together with new bone formation. This finding suggests that the fracture occurred two or three weeks prior to birth.

M. L. CONNELLY, M.D.

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Two Cases of Primary Osteomyelitis of the Pubic Bone. John J. Dinan. Canadian Med. Assn. Jour., **41,** 436–442, November, 1939.

The author presents a table of 34 cases of primary

osteomyelitis of the pubes reported from 1883 to 1937. Two personally observed cases are added.

Case 1. A girl, 16 years of age, fell astride the corner of a table. On admission to the hospital 14 days later, films of the pubes and other pelvic bones showed nothing unusual. Films seven days later revealed necrosis of the body of the left pubic bone. Surgical procedure followed. Her condition became worse, and within three weeks the major part of the pubic rami was involved. The body and rami of the left pubic bone were resected. In the fifth month of the disease, the left ischium and part of the left ilium were removed. In the seventh month the patient died. Permission for autopsy was not obtained.

Case 2. Two weeks before admission to the hospital, a 34-year-old woman had aborted a five months' pregnancy. After a stormy course of extensive pelvic cellulitis and thrombophlebitis, recovery occurred. Two weeks later pain occurred in the pubic region. A provisional diagnosis of osteomyelitis was confirmed by x-ray findings of rarefaction in the right pubic bone. Operative interference was immediate and radical. Recovery was uneventful.

In reviewing the cases, the author believes the results were probably more favorable in the second case due to earlier and more radical surgical procedure.

M. L. CONNELLY, M.D.

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Osteochondritis Dissecans. R. C. Burr. Canadian Med. Assn. Jour., **41**, 232–235, September, 1939.

Osteochondritis dissecans is most commonly found in the knee joint, lateral to the medial condyle of the femur. Other sites reported are the medial condyle and capitellum of the humerus, highest point of femoral head, and in the shoulder. Involvement of the ankle has been described in a few cases.

The author presents one case of osteochondritis of the knee and two of the ankle. Diagnosis of the knee and one ankle was confirmed by surgery. The lesion in the knee presented a typical picture. In the ankles, the superior medial articular surface of the talus was involved. This is the site in previously reported cases.

M. L. CONNELLY, M.D.

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The Significance of Asymmetry of the Pori Acustici as an Aid in Diagnosis of Eighth Nerve Tumors. John D. Camp and Earl I. L. Cilley. Am. Jour. Roentgenol. and Rad. Ther., **41**, 713–718, May, 1939.

Individual bones, totalling 509, were examined and, of this number, 250 pairs were used for comparative study. Roentgenograms of the bones were made in pairs, using two positions: the first, with the bones horizontal and in close contact with the film; the second, with the bones at an angle of 45 degrees with the film so that the long axis of the porus acusticus was parallel with the film. A target–film distance of seven feet was used. The porus acusticus was, at most, 1.5 in. from the film and thus the measurements are accurate to within 0.2 mm. The best position is the anteroposterior, which throws the pyramids into the orbit.

The shape of the canal was divided into four groups: straight, narrowed medially, narrowed laterally, and oval. The porus acusticus was considered straight when the diameter varied not more than 0.5 mm. The variation in the diameter was marked, varying from 2.5 to 11 mm.

In 250 cases comparing the right side with the left in the same skull, considerable variation was found both in size and shape, the diameter varying up to 2.5 mm.

Examination of specimens at necropsy revealed that the thin posterior wall of the internal meatus was usually destroyed to some extent by the tumor mass which caused dilatation of the porus with consequent shortening of the canal. The depth in a number of cases was measured directly and varied from 3 to 16 mm. In the same skull it varied up to 5 mm. The diameter of the mesial end varied up to 2.5 mm.

Ten cases of acoustic neuromas are cited. In the majority, the porus acusticus is dilated and the apex markedly thinned. The most marked bone changes occurred in patients who gave the shortest histories. Although roentgen examination may help, it cannot rule out the presence of a tumor. The occasional presence of erosion and elevation of the petrous ridge and changed shape of the porus acusticus afford supporting evidence

S. M. ATKINS, M.D.

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A Roentgenologic Study of the Course of Tuberculosis of the Pubis. Giovanni Codecà. Arch. di Radiol, **15**, 17–33, January–April, 1939.

The author presents 22 roentgenograms of this lesion which occurred in 5 per cent of 2,000 cases of osteoarticular disease, studied in Pavia, and from them he concludes that the diagnosis can be made only by collaboration of clinician and roentgenologist.

EUGENE T. LEDDY, M.D.

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A Case of Osteopoikilosis. Melot and Massa. Bruxelles-med., **19**, 544–547, Feb. 26, 1939.

The authors report a case of osteopoikilosis in a woman 28 years of age. The condition was discovered incidental to pyelography, consequent to a history of urinary infection. The pelvis and sacrum were particularly involved but only the cranial bones were free. The serum calcium was 11.4 mg. per cent, inorganic phosphorus 2.9 per cent, and the phosphatase (Roberts), 5.3 units.

The subject of osteopoikilosis is discussed briefly.

S. R. BEATTY, M.D.

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Slowly Progressive Pneumococcic Osteomyelitis. Raphael de Barros and Ney Penteado de Castro. Ann. paulist. de med. e cir., **38**, 163–168, September, 1939.

The authors report the case of a 37-year-old female who when 12 years of age was taken ill with cough, pain in the thorax, high fever followed, in a few days, by intense pain in the right coxofemoral articulation, right

wrist, and right shoulder. These areas became edematous and very tender, developing into abscesses which suppurated freely. Fistulous openings developed, through which occasional sequestræ came out. She was confined to bed for one year. The fistulous openings would close, at which time the pain would return and not be relieved until drainage was re-established. The illness has lasted for 25 years. Bacteriologic studies of the pus have yielded pure cultures of pneumococci. As the course of the sickness has been continuous, it is safe to assume that these bacteria were the original etiologic factor. Roentgenologic examination reveals that there is osteomyelitis as well as arthritis of the hip, wrist, and shoulder.

ANTONIO MAYORAL, M.D.

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Charcot's Joint. K. K. Sherwood and L. R. Hutchins. Northwest Med., **38,** 257–260, July, 1939.

The authors, in the opening paragraph of this essay on Charcot's joint, state: "While the diagnosis may be made in the advanced case by casual inspection, its early diagnosis is dependent upon a thorough examination and accurate observation of the reactions of the patient." This statement is of special interest to the roentgenologist who quite often gets the first opportunity for a correct diagnosis and who may be misled to mistake a Charcot's joint for an osteo-arthritis, or *vice versa,* if he relies solely on roentgenograms. The etiology is generally believed to be repeated trauma to a trophic joint, although a single sudden trauma may precipitate the joint lesion. The discovery of neurologic symptoms may precede or follow the discovery of the bone changes.

The incidence is given as from 5 to 10 per cent in tabetics and 25 per cent in cases of syringomyelia. The writers found a positive blood Wassermann in 80 per cent of their cases, and caution against being misled by negative findings. They emphasize the disparity between the patient's complaints and the physical findings, this being especially striking when the roentgenograms are studied.

ANTONIO MAYORAL, M.D.

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Deutschländer's Disease (Pied Forcé). F. Halpern. Schweiz. med. Wchnschr., **69,** 664, 665, July 22, 1939.

The author reports two cases of fracture of the second metacarpal without trauma (Deutschländer's disease, pied forcé, march foot). In discussing the disease, he divides it into two classes (after Zeitlin), the chronic or subacute, which shows a weakened foot balance, concentric hypertrophy of the bones with increase in transverse diameter, coarsening of the spongiosa, and thickening of the cortex, and the acute, which shows a spindle- or globular-shaped shadow around an infraction. The disease occurs only in abnormal feet. Morton describes four diagnostic signs:

1. Thickening of the second or third metatarsal.
2. Hypermotility of the first metatarsal, with increased intertarsal spaces.
3. Shortening of the first metatarsal.
4. Dorsal displacement of the sesamoids.

Since the first metatarsal is normally shorter than the second, the author stresses that the shortening must be of abnormal degree. A brief statement as to the mechanics of the fracture is included.

Treatment is usually by rest, but the author obtained satisfactory results with properly fitted shoes containing an arch support for flat feet.

L. G. JACOBS, M.D.

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The Diagnosis of Schüller-Christian's Disease. A. Schüller. British Jour. Radiol., **12,** 225–228, April, 1939.

The surest criterion for the diagnosis of this condition is the finding of xanthomatous tissue and the chemical proof of cholesterin-containing lipoids in the diseased areas. Biopsy is not always possible. The important clinical signs are: predilection for childhood, though it may be seen in adults; insidious onset; remissions; onset usually in the skeleton.

The x-ray examination shows multiple areas of destruction in the skull. Other bones may be involved, especially the pelvis and ribs. Occasionally single defects are seen, then the diagnosis is difficult.

The differential diagnosis between Schüller-Christian's disease and syphilis, tuberculosis, cancer, myeloma, osteitis fibrosa cystica, and suppurative osteomyelitis must be made.

The healing process may produce hyperostosis.

Three illustrative cases are quoted.

SYDNEY J. HAWLEY, M.D.

## CALCIFICATION

Interstitial Calcinosis: Report of a Case and Review of the Literature. Bernard I. Comroe, George W. Chamberlin, and F. William Sunderman. Am. Jour. Roentgenol. and Rad. Ther., **41,** 749–757, May, 1939.

The case reported is that of a white male, aged 62. Non-tender nodules which had appeared over the small joints, as well as in other soft parts, after local trauma, were radiopaque. They consisted of gray cheesy material containing calcium, phosphorus, and magnesium in the usual proportion for calcified structures in the body. Autopsy revealed bilateral pyelonephritis, benign prostatic hypertrophy, normal parathyroids and bone marrow.

Calcinosis refers to the deposition of calcium salts in the skin and subcutaneous tissues. Its etiology is unknown and it has been noted in diseases like scleroderma, Raynaud's, chilblains, acrocyanosis, and muscular fibrosis. No differences in the lesions have been observed between those of calcinosis circumscripta and calcinosis universalis.

At onset, the nodules may be tender and movable; later, when they enlarge, they may become fixed. The generalized form is most frequently seen in children, its course being slow, and, in the later stages, it may result in muscular atrophy, contractures, and ankylosis.

Roentgenologically, these calcified nodules are not connected with bone, the bones show no demineralization, and arthritic changes are usually absent. In the adult, health is not impaired nor life shortened. In the general form, prognosis is poor and treatment unsatisfactory.

S. M. ATKINS, M.D.

## CALCULI

Factors in Recurrence of Renal Calculi. Charles C. Higgins. Jour. Am. Med. Assn., **113,** 1460–1465, Oct. 14, 1939.

Recurrent renal calculi may be of either one of the following two types: (1) True recurrence or the formation of a calculus after complete removal of the original stone; (2) false recurrence, or a persistence of stones or fragments of a calculus overlooked at the time of operation. A small calculus may be so overlooked, especially if multiple stones are being removed. Unless a roentgenogram is secured before the patient is dismissed from the hospital, a recurrence, either asymptomatic in type or productive of renal colic, noted by roentgen studies months later, may be misconstrued as a true recurrence or a stone that formed *de novo*, whereas it is really a false recurrence. A roentgenogram should be secured of the exposed kidney at the time of operation.

Many factors may be associated with the formation of recurrent renal calculi. An intensive pre-operative investigation is required in each individual case to ascertain the factor or factors instrumental in the production of the primary calculus. Their correction and eradication at the time of operation or in the post-operative routine is rewarded by a reduction in the incidence of recurrence. In addition, control of the *p*H of the urine by the high vitamin A acid ash or alkaline ash diet, depending on the chemical constituents of the stone removed at operation, is attended by a pronounced decrease in the incidence of recurrent formation of calculi.

CHARLES G. SUTHERLAND, M.D.

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Calcium and Phosphorus Excretion in the Urine of Patients with Renal or Ureteral Calculi. R. H. Flocks. Jour. Am. Med. Assn., **113,** 1466–1471, Oct. 14, 1939.

Two groups of factors may be considered as fundamental in the pathogenesis of renal stone: (1) those factors which so change the nature of the renal substance as to favor precipitation of the crystalloids within it, and (2) those factors which favor the precipitation of crystalloids in the urinary passageway. Either or both factors may be operant at the same time or at different times.

Damage to the kidney substance predisposing to the precipitation of crystalloids is of importance in many cases. Precipitations of this sort appear experimentally and clinically in vitamin D "poisoning" and in hyperparathyroidism. In both these conditions there is an increased urinary calcium excretion. This excessive excretion may be the underlying factor, at at least a very important factor, in the formation of these calcium deposits. Vitamin A deficiency may act by destroying the vitality of the renal epithelium, thus permitting the precipitation of calcium and phosphorus within it. Infection in the renal pelvis itself and obstruction to the outflow of urine from the pelvis may likewise damage the kidney substance.

A study was made of the urinary excretion of calcium and phosphorus under fixed conditions in a group of 35 patients with renal calculi. In 23 of these high urinary calcium excretion was found. In three of 12 with low urinary calciums there was a history suggesting increased urinary excretion of calcium at a time when the calculi probably started. Two of the latter group showed clinical evidences of hyperparathyroidism.

CHARLES G. SUTHERLAND, M.D.

## CANCER

Changes in the Radiologic Picture in the Course of Roentgen Therapy of Metastatic Cancer of the Breast. LaMarque, Bétoulieres, and Guibert. Bull. et mém. Soc. de radiol. méd. de France, **27,** 106–113, February, 1939.

Cancer of the breast produces three radiologic types of metastatic involvement of the bone: osteolytic, osteoplastic, and a mixed type. The picture in the osteoplastic type does not change even after symptomatically effective irradiation.

Recalcification of the osteolytic types appears in the following three ways:

1. Reappearance of normal outline and structure.
2. Recalcification with persistence of any deformity that has occurred.
3. Recalcification of atypical forms often giving rise to amorphous deposits of osteoid tissue with varying amounts of calcium.

Two cases illustrating the beneficial effects of roentgen therapy in cancer of the breast are presented. No case of metastatic cancer not *in extremis* should be denied irradiation. "Would one refuse digitalis to the cardiac because the heart lesion cannot be cured?"

S. R. BEATTY, M.D.

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Pulmonary Cancer in a Brother and Sister. Milan Smokvina and Dinko Sucic. Radiol. Glasnik, **3,** 70–78, June, 1939.

The authors describe two cases, that of a 46-year-old bank employee and his 56-year-old sister, who presented bronchial carcinomas extending into the upper lobes. Their mother had died of cancer of the uterus. Heredity is considered an essential factor in the development of these cancers.

ERNST A. SCHMIDT, M.D.

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Teleroentgen Therapy in the Treatment of Cancer. Vincent Paschetta. Bull. et mém. Soc. de radiol. méd. de France, **27,** 100–102, February, 1939.

The author is now convinced of the favorable effects of teleroentgen therapy on the general state of the cancer patient. There is a definite improvement in most cases and temporarily the progress of the disease is stayed.

This effect must be due to some alteration of the biochemical processes of the body. If this is so it may be potentiated by some induced change in these processes combined with roentgen therapy.

Injection of cynnozyl and sterandryl have been of little value, but with choline the author has noted augmentation of the beneficial effects of teleroentgen therapy.

Irradiated (ultra-violet) choline has not produced any greater effect. The number of cases treated has been insufficient to allow the development of definite conclusions. Such investigations should be carried out as generally as possible.

S. R. BEATTY, M.D.

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Uterine Cancer: Roentgen-ray Therapy. Daniel G. Morton. California and West. Med., **51,** 298–302, November, 1939.

This paper covers very completely the method which the author follows in the treatment of uterine cancer by x-ray and radium. His cases are tabulated and the end-results given in a table of 270 patients. His discussion on the reactions which these patients show is of value and his method of treating these complications of interest. His summary and conclusions are as follows:

"One hundred cases of cervical cancer in which high voltage roentgen radiation was employed as a part of the treatment have been analyzed. Only 32 of these patients were treated more than five years ago. The early results indicate improvement over those obtained with radium alone. While we believe that we may infer that roentgen radiation is a valuable part of the treatment of cervical cancer, the small number of cases does not permit definite conclusions. Severe immediate reactions to roentgen radiation occurred in about one-fifth of the cases. The majority of these followed supervoltage radiation and occurred when more than 3,000 r per field was given. There were six deaths associated either directly or indirectly with roentgen therapy."

*Conclusions.*—(1) High voltage roentgen radiation is of value in the treatment of cervical cancer. (2) Roentgen therapy carries a morbidity and mortality.

JAMES J. CLARK, M.D.

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The Tumor Clinic of the Cincinnati General Hospital: A Record of its First Decade. William M. Millar and Minnie Landen. Ohio St. Med. Jour., **35,** 1069–1074, October, 1939.

The authors review the growth, development, and affiliation with both teaching and social service institutions of this tumor clinic. This pooling of resources allows for adequate study, therapy, and follow-up of all tumor cases in the locality with the use of radium, surgery, and x-ray facilities. Centralization allows for adequate follow-up and statistical studies. In the 10 years from 1928 to 1938, 1,099 cases of carcinoma were diagnosed and treated; 1,502 other patients referred as suspect carcinoma cases were proven to be non-cancerous. Of the cases treated, 59 survived three-year periods and of these 20 are grouped as five-year cures. Although this percentage is low and covers a wide variety of malignant diseases, one must take into account the high percentage of far advanced cases seen in this type clinic and realize the extensive palliative effect of adequate therapy in these cases.

SIMON POLLACK, M.D.

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Dental Lesions Observed after Roentgen Therapy in Cancer of the Buccal Cavity, Pharynx, and Larynx. J. A. del Regato. Am. Jour. Roentgenol. and Rad. Ther., **42,** 404–410, September, 1939.

Usually dental lesions appear slowly over a course of four or five years and may or may not be painless. They seem to be produced by an indirect mechanism because very often they are observed in patients whose teeth or maxillæ have not been irradiated.

Grossly these lesions are notably (*a*) a superficial caries of the neck of the tooth which extends around the tooth and finishes by an amputation at the gum line; or it extends over the entire surface of the tooth; (*b*) an early wearing away of the incisal edges or occlusal surfaces of the tooth with progressive diminution in its height.

Such lesions may end in necrosis of the maxilla of more or less serious consequence which may endanger the life of a patient who otherwise seems to be cured. In the more favorable cases, the patients are unable to masticate for a considerable length of time and must wait for spontaneous elimination of roots before they can wear a denture.

In awaiting the time when one can avoid the production of these lesions by modifications of technic in roentgen therapy, a preliminary extraction of the greater number of teeth is a prudent procedure.

S. M. ATKINS, M.D.

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